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NUCLEAR SCIENCE ABSTRACTS

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BIOLOGY AND MEDICINE

903 Dosage-mortality in rats given total body roentgen irradiation. W. G. Clark and R. P. Uncapher. *Proc. Soc. Exptl. Biol. Med. 71*, 214-6(1949) June.

Over 500 young male rats were used in studies to determine the dosage-mortality ratio for total body roentgen irradiation. The doses were delivered at different lengths of time by a 200-kv machine, at 52.5 cm target distance, and through 1/2 mm Cu and 1 mm Al filters; the dose-rate was 30.4 r/min. in air. The mortality data represent indefinite survival of the rats (past 30-60 days) and are included in three graphs. The results show that the maximum dosage for rats in this series is 640 ± 5 r with a 30-day end-point. Because of the steep mortality curves in the rat groups, and the consequent errors in calculation, dosages in the lethal range should not be used.

904 Exposure to microwaves. W. W. Salisbury, J. W. Clark, and H. M. Hines. *Electronics 22*, 66-7(1949) May.

A large number of preliminary experiments conducted with anesthetized laboratory animals indicate that injury by exposure to microwave radiation may occur at relatively low field intensity, particularly in the vicinity of 10-cm wavelength. It has also been found that pain cannot always be relied upon to warn of a dangerous field. No standards of safety have as yet been established; in the meantime, microwave radiation should be treated with the same respect as x-rays, α-rays, and neutrons.

905 Relation of pregnancies to induction of ovarian tumors by x-rays. J. Furth. *Proc. Soc. Exptl. Biol. Med. 71*, 274-7(1949) June.

Several series of x-radiation experiments on mice one day to 10 weeks old are described, in which the doses were 25-200 r and were given to females, some of whom later became pregnant. The results show that mice exposed to 50-200 r of the rays can have one or several pregnancies and be still liable to the development of ovarian tumors in a stock in which this neoplasm is practically nonexistent. The irradiation at 1-3 days of life with 150 r sterilized only 1/3 of the mice while ovarian neoplasms appeared in about 76%; but the irradiation did not hasten the onset of ovarian neoplasm as compared to irradiation at 4-10 weeks. In both of these groups the tumors developed in middle aged and old mice. The growth rate of the tumors was also slow, hardly interfering with the normal life span of these animals. It is postulated that a specific delayed x-ray effect coupled with a hormonal imbalance provoked by x-rays leads to the development of ovarian tumors.

906 The response of the peripheral blood of swine to whole body x-ray radiation in the lethal range. E. P. Cronkite, F. W. Ullrich, D. C. Eltzholtz, C. R. Sipe, and P. K. Schork. Naval Medical Research Institute Project NM-007-039 Report No. 21, Apr. 7, 1949. 12p.

Four groups of swine containing 4, 4, 12, and 4 animals were exposed to 200, 300, 400, and 600 r, respectively, delivered bilaterally from a 1000 kv industrial x-ray tube. The mortality in the groups was as follows: 200 r, 12.5%; 300 r, 87.5%; 400 r, 100.0%; 600 r, 100.0%. The expected leukopenia appeared with cell levels of the order of 1 to 3000/cmm after six to seven days, the initial levels being about 17,000/cmm. The response of the peripheral leukocytes in the 200 r group showed a less rapid downward trend than that of the other groups. A reticulocytosis, in general, preceded recovery and could be used as a fair but not invariable sign of recovery.

907 Studies of the effect of roentgen rays on healing of wounds. III. Histological changes in skin wounds in rats following postoperative irradiation with very small and moderate doses. E. A. Pohle, G. Ritchie, and W. W. Moir. *Radiology 52*, 707-13(1949) May.

The effect of roentgen rays in doses of 10, 25, 150, 300, 350, and 700 r on the healing of skin incisions was studied macroscopically in 18 and macroscopically and microscopically in 122 white rats. The radiation doses were administered by a 100-kv machine, through a 2 mm Al filter, at a target distance of 30 cm and at the rate of 45 r/min. Although all wounds were examined daily, no consistent difference in the healing time between the irradiated and the non-irradiated portions of the wound could be detected macroscopically. Histologically, no true stimulative effect on the healing -- even with the lowest doses used -- could be found. Any slight difference in the healing process in favor of the irradiated portion (small doses only) was considered to be due to a reduction in the amount of exudate, which in turn decreased the amount of fibrin replaced by the scar tissue.

BIOLOGY AND MEDICINE (continued)

908 Acute pneumonitis in workers exposed to beryllium oxide and beryllium metal. J. C. Aub and R. S. Grier. *J. Ind. Hyg. Toxicol.*, *31*, 123-33(1949) May.

A series of seven cases of acute pneumonitis developing as a result of exposure to the dusts and fumes of beryllium and beryllium oxide is presented. The average exposure time was three months, with the exception of one case of three years. The chief symptom was exertional dyspnea; other prominent symptoms were fatigue, pains in the chest, coughing, gastrointestinal symptoms, and fever. No cyanosis or clubbing of the fingers was observed. The average duration of time taken for the appearance of the symptoms was 2-2½ months. All the cases had negative urinalyses and serologies, but there was an incidence of excessive hemoglobin and rbc counts. The x-ray findings ranged from increased perihilar shadows with diminished radiance of the lung fields to extensive granular infiltration. The author notes that these are the first reported cases of reaction to pure beryllium and beryllium oxide.

909 Failure of rutin to inhibit hyaluronidase in the albino rat. S. K. Elster. *Proc. Soc. Exptl. Biol. Med.* 71, No. 1 15-18(1949) May.

Experiments to determine the influence of rutin and propylene glycol on the blood hematocrit, and the influence of rutin on the properties of hyaluronidase in vivo are described. Although almost inactive when administered orally, 200 mg of rutin suspended in saline and given intraperitoneally to a rat acted as an irritant and caused the formation of a hydroperitoneum. Propylene glycol had a similar, although lesser, action. A mixture of the two was a very active agent and caused so much peritoneal fluid loss that marked hemo-concentration occurred. These studies also demonstrated that rutin was unable to modify the action of hyaluronidase on edema formation and the elevation of the hematocrit in the albino rat, although previous researchers had found an inhibiting action by rutin on hyaluronidase in vitro, which was accentuated by vitamin C.

910 Interim recommendations for the disposal of radioactive wastes by Off-Commission users. Isotopes Division Circular IDB-6, nd. 10p.

Basic considerations on disposal of radioactive wastes by dilution and dispersion, and by confinement and control are reviewed. Procedures are recommended for disposal of I^{131}, P^{32}, and C^{14}. Consideration is given to means for disposing of any type of radioisotope.

911 The problem of plantar radiodermatitis. A. H. Montgomery, R. M. Montgomery, and D. C. Montgomery. *N. Y. State J. Med.* 49, 1664-7(1949) July 15.

The problem of plantar radio-dematitis and its treatment is presented. The treatment may either be surgical or conservative with a view toward healing the area and preventing ulcer formations by means of soothing or stimulating remedies. Reconstructive surgery is advised for all cases with ulceration in an area of 0.4 cm or more.

912 The protection of personnel engaged in roentgenology and radiology. F. T. Hunter, O. E. Merrill, J. G. Trump, and L. L. Robbins. *New England J. Med.* 241, 79-89 (1949) July 21.

An exposure film badge is described (which measures the exposure dose and the quality of the radiations) in connection with a preliminary report on the investigation of direct and indirect radiations to which radiologists are exposed. It was found that the scattered radiations during a flouroscopic examination are much more penetrating than the direct beam, and, while greatly reduced in intensity, are still capable of penetrating the blood-forming organs of the examiner. The technique of manipulation of the film badge described here is presented, together with methods of processing the film and interpreting the exposure dose. The significance and importance of the physical data acquired from this investigation are discussed in detail, and graphs of the intensities of radiation under filtering conditions and voltage changes are included. A monitoring system for the x-ray personnel is also described, and consists of the uniform use of film badges and examination of the blood (hemoglobin determination, white-cell count, differential count and a description of the stained smear), the results of which are tabulated periodically and entered in individual health records. 14 references. 10 figures.

BIOLOGY AND MEDICINE (continued)

913 Some practical considerations in radiation shielding. G. W. Morgan. Isotopes Division Circular IDB-4, Nov. 1948. 16p.

The purpose of this paper is to supply the users of radioisotopes with some basic formulas which may be used in determining dosage rates for gamma radiation and shielding values for both beta and gamma radiations. Derivations of formulas, using specific examples, are included for the benefit of those having limited mathematical background. Data are included in tabular and graphic form on the shielding values of the most commonly used shielding materials.

914 Studies of the effect of the protraction of x-radiation by 12 fractionations on the erythema reactions. H. Schöttelndreyer. *Brit. J. Radiology 22*, 386-92(1949) July.

Three experiments were carried out on women patients in order to study the effects of the protraction of x-radiations on the erythema reactions. Two of the patients were under treatment for gynecological carcinomas and the third was being treated for an inflammation of the adnexa; all had normal skin conditions at the time of treatment. Each experiment is described in detail. The results show that the biological effect of a single irradiation with 631 r on the skin is equivalent to that of 2064 r when given in 12 fractions irrespective of whether an effective dose rate of 5.25 r/min or a rate of 112 r/min is used, confirming the observation of Kepp (*Strahlentherapie 72*, 195(1942)) that, when using 12 fractionating doses, protraction of the delivery time has practically no effect on the biological erythema dose. Similarly, it was found that a similar protraction does not have any detectable influence on the erythema effect using 12 fractions when the above doses are increased or decreased by 20%. The sensitivity of the reaction lies between ± 10 to ± 20% of the normal dose.

915 Effects of radiation therapy on the urinary excretion of niacin and riboflavin in patients with malignant diseases. Relationship to radiation sickness. J. L. Jarvis and D. Cayer. *Radiology 52*, 574-8(1949) Apr.

Experiments to determine whether malnutrition predisposes radiation sickness are presented in which the urinary excretion of niacin and riboflavin in a group of patients with malignant disease was measured before and after x-ray therapy. Of the 30 patients studied, 21 received total radiation doses of 1,800-8,120 r. Four patients received radium doses of 3,600-4,800 mg-hr and five patients received a combination of the two types of therapy. The excretion levels of niacin and riboflavin are given in a table included in this paper. Seven patients who had nausea and vomiting show significantly lower vitamin excretion levels than those without these symptoms. Good results have been obtained by the use of vitamins of the B complex for radiation disease therapy. 16 references.

916 Studies of the effects of flavonoids on roentgen irradiation disease. 1. Protective influence of rutin in irradiated dogs. J. B. Field and P. E. Rekers. *Am. J. Med. Sci. 218*, 1-15(1949) July.

Sixty per cent of a group of dogs given a single dose of 350 r total body x-irradiation died when left untreated, 36% of a similar group succumbed when treated with a preparation derived from lemon peels, and 11% of a third group died when rutin was given before and after the radiations. When rutin was only given before the radiations, 33% of the dogs died, and when only given afterwards 60-80% of the animals succumbed. Hemorrhagic diathesis appeared more frequently in the untreated specimens and those receiving rutin than in the remainder of the animals. Rutin prevented petechiae and caused a reduction in hemorrhagic signs despite a depression in the blood platelet count and a moderate hypo-coagulability; the rate of anemia production and the magnitude of the increased sedimentation rate were reduced while the erythroblast forms and the nucleated red blood cells were increased. Septicemia was present in 62% of the dead dogs, but it is suggested that the primary cause of death in animals receiving the 350 r was a bleeding tendency associated with a vascular dysfunction, as well as a thrombocytopenia. The existence of "vitamin P" is claimed to be supported by this report and it is suggested that this investigational method may be used as part of an assay for this vitamin substance. 38 references.

917 Anti-histamine ointments for skin protection in radiation therapy. M. P. Mains. *Radiology 52*, 579-581(1949) Apr.

Some anti-histamine ointments, beneficial in combating radio-dermatitis caused by the release of histamine and histamine-like substances during tissue damage, are discussed. The author advocates the use of Aquaphor as a base for both Benadryl and Pyribenzamine in 5%

BIOLOGY AND MEDICINE (continued)

strength. Using 200 kv at 50 cm target distance with 0.5 mm Cu and 1.0 mm Al filters, 1,800 r in air formerly produced marked skin reactions. Doses as high as 2,400 r in air produce less reaction when the anti-histamine ointments are applied to the treated skin. Examples are given of the beneficial and protective effects of oral and local anti-histamines in specific cases treated by the author.

918 Carcinoma of the thyroid gland. W. E. Howes and M. N. Foote. *Radiology 52*, 541-56(1949) Apr.

A detailed discussion of carcinoma of the thyroid gland is presented in which medullary or anaplastic carcinoma, papillary carcinoma, adenocarcinoma, Hurthle-cell carcinoma, squamous-cell carcinoma, sarcoma, and three cases of unclassified carcinoma are discussed under separate headings. Irradiation therapy was performed by means of x-rays, radium, and radioactive iodine. Twenty-six patients received x-ray therapy in which 100-200 r in air was delivered daily at 200 kv through 0.5 mm Cu and 1.0 mm Al at 50 cm target distance to each of two portals until a tumor dose of 3,000-5,000 r was given. Lymph node, pulmonary and bone metastases were observed to be uniformly more resistant to equivalent doses of radiation than the parent tumor. Insertion of radon seeds after thyroidectomies provided for the delivery of up to 5,000 gamma r to the areas; the response to this therapy was minimal except in the case included. Six patients received radio-iodine I^{131}, in single or multiple doses; this method resulted in symptomatic relief in two cases.

919 Effect of roentgen therapy on mouse encephalitis. W. A. Tanner and J. E. McConchie. *Radiology 53*, 101-3(1949) July.

Experiments determining the effect of roentgen therapy on groups of six-week-old mice inoculated with mouse encephalitis are presented. An experiment to determine the effects of x-rays on mice was divided into three classes: Those receiving whole body irradiation of 50 r for six days; those receiving 200 r daily only to the head region for three days; and those receiving 100 r daily only to the head region for six days. After the radiations, which were delivered at 90 kv and at 16 in. distance through 2.0 mm Al filter, the mortalities were found not to be related to the radiations. Five groups of 16 mice were then inoculated intracerebrally with 100 LD_{50} doses of FA (Theiler's) mouse encephalitis virus and then subjected to a constant x-ray dose (50-200 r) to a given portal for a definite period of time. Two of the groups were irradiated with 50-100 r daily for the first six days following their inoculation with the virus, and three groups were irradiated from six to eleven days after inoculation, when the symptoms were expected to appear. The results are included in a table, as are the results from a similar experiment performed under the same conditions except for a lower inoculation dose (10 LD_{50} doses instead of 100 LD_{50} doses). There was no significant difference in the percentage survival rate or in the clinical manifestations between these two series of treated animals and the inoculated controls.

920 Graves' disease: treatment with radioiodine (I^{131}). M. H. Soley, E. R. Miller, and N. Foreman. *Mississippi Valley Med. J. 71*, 131-4(1949) July (See Nuclear Science Abstracts 1-250 and 2-1278).

The results of studies to determine the therapeutic effects of radio-iodine in the treatment of hyperfunctioning thyroids, and to determine the rate of uptake of iodine before and after symptoms of Graves' disease are relieved, are presented in this report. Prior to the studies on humans, the effects of I^{131} were studied in dogs and rabbits by administering 300 mc per kg body weight of I^{131} subcutaneously. At the end of ten days, the rabbit thyroids showed extensive necrosis, hemorrhage, polymorphonuclear infiltration and arterial hemorrhages. At the end of 30-40 days further gland fibrosis had occurred, and the arteries had intimal and medial fibrosis, thickenings and perivascular fibrosis. Dog thyroids removed at 40 days after the injections showed similar changes. After administration of 500-4,000 mc/lb of body weight in rabbits thyroids showed partial or complete destruction in 28 days, and evidence of tracheal and renal tubular injury was also present. The maximum amounts of I^{131} taken up by the thyroids of 46 patients with Graves' disease was 12.5-92% of an orally administered dose. The total dose of I^{131} given in these cases was usually 3,017 mc with a few cases receiving 4,838 mc due to slow response to the treatment. Forty-two patients received satisfactory results from the treatments. The only complication was the development of myxedema in two patients treated with the I^{131}. From these studies it was also noted that I^{131} doses as low as 2 mc produce some evidence of tissue destruction in the thyroid.

BIOLOGY AND MEDICINE (continued)

921 Graves disease. Twenty-five year follow-up of cases receiving roentgen therapy. J. M. Read. *Radiology 52*, 557-63(1949) Apr.

A report on the present status of 15 patients who received roentgen irradiation for Graves' disease 25 years ago is presented. The general technique for the irradiations was weekly exposures of 200 r over each lobe, the rays being generated at 130 kv and filtered through 0.25 mm of Cu and 1.0 mm of Al. Twelve treatments constituted a full course; twelve of the patients received total dosages of 600-6,090 r. Nine of the patients are still living and well at the ages of 34-73 years; three are dead from other causes; one has undergone thyroidectomy with only fair results; and one is living at the age of 71 with a chronic form of the disease. No ill effects of the roentgen therapy were observed except in one case requiring several courses of treatment, with resultant skin atrophy and telangiectases over the irradiated area. The results are very satisfactory.

922 Ocular therapy by low-voltage irradiation at close distances. M. Morano and B. Franchi. *Boll. d'ocul. 27*, 625-38(1948) Oct.

Low-voltage irradiation of the eye and the precautions necessary to protect the surrounding regions are discussed. The surrounding tissues were protected by a 3 mm celluloid plate while delivering x-ray doses of 160-165 r for uveal lesions, and 190-195 r for deeper lesions for four or five applications, by means of a 55-kv machine, and at a focal distance of 5 cm.

923 Parotid tumors. A review of ninety-three cases. M. J. Smith and K. W. Stenstrom. *Radiology 52*, 655-61(1949) May.

Ninety-three cases of parotid tumors, consisting of 58 mixed tumors and 35 carcinomas, are reviewed. The dosage for the mixed tumors was usually 1,200-1,500 r in air to each of three fields; radium therapy consisted of 700-2,000 mg-hr depending on the size of the lesion. All the radiation therapy was post-operative, except that directed toward recurrences, in which case radiation was used alone. The treatment was followed by undesirable complications in 14 of the cases, four of which had skin changes over the irradiated areas (consisting of skin atrophy and telangiectasia), two suffered induration, and one had severe ulceration and bleeding; there was no instances of salivary fistula. The treatment in the carcinoma cases was the same as for the mixed tumors, except that the radiation field was wider and the doses were 1,200-1,800 r. Excision, radon insertion, and post-operative x-irradiation was the rule. The 5-year-survival rates for these cases is poor; there is an appreciable number of recurrences. 38 references.

924 Present possibilities in the therapeutical use of radioisotopes. M. Guillot. *Ann. Pharmaceutiques Francaises 7*, 141-6(1949) Feb. (in French).

This is a short note on the preparation and the medical uses of radio-isotopes. The experimentation in the treatment of cancer and leukemia gave, as yet, no conclusive results. More successful was the use of P^{32} in polyglobulia, and of radio-iodine in hyperthyroidism.

925 Radium therapy in carcinoma of the female urethra. R. E. Fricke and J. T. McMillan. *Radiology 52*, 533-40(1949) Apr.

A review of the literature on carcinoma of the urethra is presented, and the anatomy, lymphatic drainage and methods of treatment of the disease are discussed. Thirty-five cases treated with radium form the basis of this paper; the radium was administered by interstitial implants of radon or radium, radium or radon tube contact therapy, or by vaginal applicators. The treatment of the metastatic lymph nodes was by roentgen and radium therapy. A total of 44.1% of the 34 patients traced survived five years or more after the treatments; the method of choice was a combination of excision or cautery destruction with radium therapy. 13 references.

926 References on therapeutic and tracer uses of P^{32}. Isotopes Division Circular IDD-2, Nov. 1947. 12p.

A bibliography listing papers in the field by publication year (1935-1947 incl.) has been compiled.

927 Roentgen therapy of carcinoma of the skin of the eyelids. J. A. del Regato. *Radiology 52*, 564-73(1949) Apr.

This report is based on 168 consecutive cases of carcinoma of the skin of the eyelids, and of the inner and outer canthi, in patients who were admitted from May, 1940, to December, 1945,

BIOLOGY AND MEDICINE (continued)

to the Ellis Fiscel State Cancer Hospital, and who have been followed for a minimum of three years; this series included 21 patients with a recurrence following previous inadequate treatment. The clinical aspects, incidence, diagnosis, pathology, and the treatment by surgery, curie and roentgen therapy are described. Sixteen cases were treated by interstitial irradiation with radium element needles, and a dose of 200 mg-hr was usually administered in 20 hr. Roentgen therapy is considered by the author to be the treatment of choice and usually consisted in this series of radiations from a 110-kv source, with a target distance of 15 cm delivered through 0.25 mm of Cu. Basal-cell carcinomas of the eyelids required a daily dose of 100-150 r raised to 200-250 r depending on the size of the lesion. For a field of 1.5-2.0 cm, the total dose was usually 4,000-5,000 r delivered over 3-4 weeks; no less than 3,000 r total dose was given. A very small field required a total dose of 7,000 r over a period of six weeks. A moist dermatitis always occurred from these treatments. Of 161 patients with basal-cell carcinomas, 16 received interstitial curie therapy, and 134 were treated by roentgen rays. Twelve of the 16 curie therapy patients were well after five years or more, and there were nine recurrences in 117 of the roentgen ray cases. There was an overall 3-year survival rate of 78% for 168 cases treated with all types of therapy.

928 Routine management of carcinoma of the skin and lips. H. L. Traenkle. *N. Y. State J. Med.* 49, 1659-61(1949) July 15.

A general outline of the treatment methods for the routine management of carcinoma of the skin and lips is presented in which radiation therapy is discussed. The majority of previously untreated malignant lesions are treated by the author with roentgen rays. Small lesions sometimes receive a single dose of 3,500 r from a 100-kv machine at 18 cm target distance; the usual treatment is a protracted divided dose plan, consisting of a total of 4,000-5,000 r administered over a 8-12-day period. Areas of 3.5 cm or less are usually treated in 4-5 sessions, and fields larger than 10 cm^2 are treated with daily doses; lip lesions routinely receive a total surface dose of 5,000 r. Higher voltages of 140-200 kv are used in special cases and the total surface dose given them is 4,500-6,000 r over 10-20 days or more. Superficial epitheliomas are treated with a single dose of 5,000-6,000 r with the target distance of 2 cm. Methods of electrosurgery, scalpel surgery, and chemosurgery are also discussed, as is the procedure for a routine follow-up on these cases.

929 Soft-ray roentgentherapy of superficial eye diseases. G. Fedrizzi and L. Ferri. *Boll. d'ocul.* 27, 697-705(1948) Nov.

A short review of 31 cases of corneal and scleral lesions is presented in which it is noted that any roentgen apparatus may be used to deliver the necessary therapy consisting of 30-40 r per session with a total of 180-320 r. In some cases satisfactory results are reported.

930 Subacute (pseudotuberculous, giant cell) thyroiditis and its treatment. J. D. Osmond, Jr. Jr., and U. V. Portmann. *Am. J. Roentgenol. Radium Therapy* 61, 826-9(1949) June.

A description of the incidence, pathology, clinical manifestations, and the treatment of subacute thyroiditis is presented. The radiation technique used consists of the delivery by a 200-kv machine, with a filter equivalent to a 1.0-mm half-value layer of Cu and at a target distance of 50 cm; the roentgen skin dose is 100-150 r given every other day for 4-6 treatments. Of 55 cases treated by this method, 40 were cured in one course, six were cured by a second course, one suffered a recurrence, and eight remained untraced after the treatments. It is concluded that roentgen therapy is indicated for subacute thyroiditis cases. 21 references.

931 Symposium: carcinoma of the bladder. I. The treatment of cancer of the bladder by radium. A. Jacobs. *Brit. J. Radiology* 22, 393-8(1949) July.

The role of radium in the treatment of carcinoma of the bladder is discussed, and the technique of interstitial irradiation, together with the results of this therapy, is included. One hundred and ten cases were each treated with a dose of approximately 7,000 r over a period of 160 hr, the interstitial tubes being directly inserted into the muscularis of the bladder. Radon seeds were used only in a few cases, since the rate of irradiation by this method is not as even as with radium. Some complications occurred, especially in the cases receiving heavier dosages of radium; vesical tenesmus occasionally appeared. The results show that of the 110 cases treated, 37 survived five years or longer.

BIOLOGY AND MEDICINE (continued)

932 Symposium: carcinoma of the bladder. III. Treatment by radon seed implantation and deep x-ray therapy. J. L. E. Millen. *Brit. J. Radiology 22*, 402-5(1949) July.

A discussion of the two radiotherapeutic methods, radon seed, and x-ray therapy, in use at the Christie Hospital and Holt Radium Institute, Manchester, is presented in which the results of treatment during the period 1932-1942 are included. Radon seed implantation is the treatment of choice in cases of carcinoma of the bladder; the technique involved is described in detail. Cases which have the lesions in widely separated areas on the bladder are treated with radical x-ray therapy consisting of a multifield, beam- directed technique; tumor doses vary according to the size of the area irradiated and are usually around 6,000 r delivered over a period of 5 weeks. Seventy-four patients were treated by the radical x-ray method and 14% survived 5 years; the radon seed implant method yields a survival rate of 42% from 94 patients treated. Palliative x-ray therapy is also discussed. It is concluded that x-ray therapy is useful in the treatment of a portion of the advanced cases of carcinoma of the bladder.

933 Techniques in the handling of radioactive isotopes used in medical therapy and the preparation of radioactive colloidal gold. C. W. Sheppard and P. F. Hahn. Isotopes Division Circular IDA-3 (Vanderbilt University), Nov., 1947. 25p.

Methods and devices are described which have been developed in the course of an investigation of the use of colloidal Au, containing Au^{198}, in medical therapy. Information is included on the following topics: principal problems in the use of radioactive isotopes, miscellaneous equipment, arrangement of a chemical hood for radiochemical processes, radiation monitoring and surveys in the laboratory, measurement of radioactivity, and the preparation of therapeutic quantities of radioactive colloidal Au.

934 Treatment of testicular tumors. J. J. Okker. *Nederland. Tijdsch. Geneesk. 1*, 140-2(1949) No. 2.

The importance of roentgen therapy immediately following an orchidectomy for a malignant testicular tumor is stressed since, the author states, it may be assumed that there are metastases present. The roentgen irradiation of the regional lymph nodes permitted a 40% 5-year survival rate for these cases. Teratoid tumors were less sensitive to the radiations than seminomas.

935 The use of interstitial radon seeds and needles in inoperable lung cancer. I. M. Ariel, J. R. Head, H. T. Langston, and E.E. Avery. *Cancer 2*, 581-6(1949) July.

A method is described of inserting large doses of radon in seeds and needles into and around lung cancer deemed inoperable during an exploratory thoracotomy and involves the use of 1, 2, and 4 mc of radon per needle; the therapy is arranged so as to provide 6-10 threshold erythema doses to all parts of the neoplasm, that is 2,660-15,864 mc-hr in the cases discussed here. Of 17 patients treated by interstitial radon, 16 have succumbed an average of five and six-tenths months following therapy. One patient is alive and asymptomatic ten months after therapy. The method has offered definite palliation but has not significantly prolonged life. The difficulty of securing correct distribution precludes the use of this method where a surgical cure can be anticipated, and in small lesions that are inoperable because of location (carina, etc.), external irradiation is the method of choice. 16 references.

936 Value of x-ray therapy in orthopedic cases. C. M. White and C. Rombold. *J. Kansas Med. Soc. 50*, 325-9(1949) July.

These cases include bursitis, spondylitis, fibrositis, synovitis, two types of arthritis, and a small number of other types. The therapy was conducted by a 200-kv machine, delivering the radiations through 1 mm Cu and 1 mm Al filters at a focal distance of 50 cm. In chronic cases the doses were 200 r given once a week, four times, for a total dose of 800 r; additional treatments were occasionally given. With cases of Marie-Strumpell arthritis, a total dose of 600 r was usually given to each of two portals, at the rate of 200 r to each portal three times a week. In 62% of the total cases there was significant improvement, and there were no complications arising from this therapy in any of the cases. It is concluded that roentgen therapy is very beneficial in cases of Marie-Strumpell arthritis, synovitis, and shoulder bursitis, and of some benefit in osteoarthritis and fibrositis. 15 references.

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937 The blood volume of the adult rat, as determined by Fe^{59} and P^{32} labelled red cells. N. I. Berlin, R. L. Huff, D. C. Van Dyke, and T. G. Hennessy. *Proc. Soc. Exptl. Biol. Med.* 71, 176-8(1949) June.

Experiments to determine the blood volume of adult rats, through the use of red blood cells labelled with P^{32} and Fe^{59}, are described. Two groups of animals were used, the first group consisting of 12 adult rats with blood cells labelled by both Fe^{59} and P^{32}, and the second group consisting of 30 adult rats with blood cells labelled only by P^{32}. In each group the blood type of all the animals was the same. The method of incorporating the Fe^{59} and the P^{32} is described. The reconstituted blood was then injected into the tail veins of the rats, and after three minutes blood samples were withdrawn by cardiac puncture and assayed by the method described. The results are included in two tables and the values are discussed. The conclusions are that: the blood volume of normal rats determined by the use of Fe^{59} labelled red blood cells is essentially the same as with P^{32} labelled cells; the use of P^{32} labelled red blood cells is hence satisfactory for the determination of blood volume; determinations with P^{32} indicate that the blood volume of the normal rat is 4.59 ± 0.57/cc 100 g body weight, the total red cell volume is 2.16 ± 0.20 cc/100 g body weight, and the hematocrit is 45.8 ± 2.6.

938 Distribution of globulin-bound thyroid fractions of iodine in normal and tumorous animals after intravenous administration using radioiodine as a tracer. K. G. Scott, W. L. Bostick, M. B. Shimkin, and J. G. Hamilton. *Cancer* 2, 692-6(1949) July.

Experiments studying the localization of the globulin-iodine fractions of the thyroid in the tissues of normal and tumor-bearing animals through the aid of I^{131} are presented. The method of preparation of the radioactive thyroglobulin fractions from rats and rabbits is described. The transplantable tumors investigated in rats and mice were fibrosarcoma, adenocarcinoma, pancreatic carcinoma, lymphoma, hepatoma, and mammary carcinoma. The tagged thyroglobulin was injected into the external jugular vein in the rats and into the tail vein in the mice. The standard dose for the rats was 1/40th of the extractable material from one rabbit thyroid, containing about 1μc of I^{131}; the thyroid material given to the mice with mammary carcinoma was 1/200th of a rabbit fraction, and the dose given to mice with hepatoma and lymphoma was 1/100th of a rat thyroid fraction. The details of the experiments and the data accumulated are included. The results indicate that the presence of a transplantable tumor alters the reaction of the animal to thyroglobulin, the maximum effect being demonstrable when the tumor mass is less than 5% of the total body weight. There is also a greater accumulation of radioactive iodine in the skin of the animals with tumors; about 200% over the normal uptake was found in all the tumor-bearing mice except those with pancreatic carcinoma. The effect was also observed in two transplantable mouse tumors that were inoculated into the peritoneal cavity instead of the usual subcutaneous implantation. The authors suggest that this higher skin uptake in the skin of tumorous rats is a reflection of disturbed metabolism referable to a relationship between the tumor and the host.

939 The fate of an intraneural injection as demonstrated by the use of radioactive phosphorus. J. B. Brierley and E. J. Field. *J. Neurology Neurosurgery and Psychiatry* 12, 86-99(1949) May.

A technique for studying the fate of intraneural injections by introducing 0.05 ml of radioactive phosphorus (as phosphoric acid) into the sciatic nerve of the rabbit is described. Of the 16 injections performed, 4 were at the apex of the popliteal fossa, 6 at the midfemoral level, and 6 just above the greater trochanter. The injections fell into two groups according to their immediate local features and to the subsequent distribution of the indicator in blood, cerebrospinal fluid, and the nervous system. The following features distinguished a "cord cerebrospinal fluid" type of injection: minimal resistance to injection, absence of dilatation of the nerve, a column of fluid moving rapidly in a central direction, spread of the indicator throughout the nerve, spread of the indicator into the spinal cord, entry of the indicator into the cerebrospinal fluid, and relatively little absorption into the blood stream. The following features distinguished a "blood" type of injection: considerable resistance to injection, variable dilatation of the nerve, absence of an ascending fluid column, limited spread of the indicator within the nerve, no spread of the indicator into the spinal cord, no entry of the indicator into the cerebrospinal fluid, and considerable absorption into the blood stream. "High sciatic" injections resembled the "cord-cerebrospinal fluid" injections except that there was no appreciable entry of the indicator into the cerebrospinal fluid, while blood activity was relatively high. The

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term "cord" type was applied to these injections. It was concluded that the "cord-cerebrospinal fluid" and "cord" types of injection could be attributed to the penetration of a fasciculus by the needle point whence spread took place along the inter-fiber spaces---the pathway of least resistance within the nerve. In the "blood" type injection the needle point lay within or just under the perineurium, the injection mass creating a limited subperineural space with variable but slight penetration of the fasciculus. The employment of intraneural injections in the experimental investigation of tetanus and poliomyelitis is discussed in the light of these observations. 27 references.

940 The incorporation of radioactive carbon dioxide and acetate into liver proteins in vitro. C. B. Anfinsen, A. Beloff, and A. K. Solomon. *J. Biol. Chem.* 179, 1001-13(1949) July.

A method for the incorporation of radioactive $C^{14}O_2$ and acetate into liver proteins in vitro is presented, and consists of the incubation of rabbit liver slices with $NaHC^{14}O_3$ or CH_3-$C^{14}OONa$; the incorporation takes place in the carboxyl groups of the protein amino acids and proceeds progressively for at least 4 hours. A major portion of the incorporated carbon is found to be in the dicarboxylic amino acid fraction; the specific activity of the α-carboxyl group of glutamic acid is approximately equal to the average specific activity of the α- and β-carboxyl groups of aspartic acid. Some of the limiting factors for the incorporation process are the presence of oxygen, and the degree of mincing of the liver tissue. The addition of glutamic acid, aspartic acid, glutamine, asparagine, malate, pyruvate, and alanine have no effect on the incorporation rate of $C^{14}O_2$, while added oxalacetate decreases the rate about 50%. In experiments with $NaHC^{14}O_3$ evidence was obtained that the guanidine carbon or arginine underwent exchange with radioactive carbon. 26 references.

941 Lipogenesis from glucose in the normal and liverless animal as studied with C^{14}-labelled glucose. E. J. Masoro, I. L. Chaikoff, and W. G. Dauben. *J. Biol. Chem.* 179, 1117-25(1949) July.

The conversion of carbohydrate to fatty acids was studied in the mouse and the rat with the aid of C^{14}–labelled glucose which was introduced to mice in their feed; the experiments were then run for 24-48 hr during which time the animals had access to this diet and water. The test rats were given multiple injections of C^{14} –glucose after evisceration and sacrificed 8 hours later, while the control rats received the same number of injections at the same intervals (0, 2, 4, and 6 hr) and were sacrificed at the same time, but were not eviscerated. The results show that in the mouse maintained on a high carbohydrate, fat-free diet, 10-15% of the ingested glucose-C^{14} was incorporated into fatty acids in 24 hr, and 12-16% in 48 hr; the rat converted about 2% of the subcutaneously injected glucose-C^{14} to fatty acids in 8 hours, and C^{14} was also found in the palmitic acid of the rats which had been eviscerated. The finding of radioactive acid in the eviscerated rat shows that the conversion of carbohydrate to fatty acids proceeds in tissues other than the liver and the intestine. 20 references.

942 Movement of P^{32} in maturing corn plants. C. L. Withner. *Plant Physiol.* 24, 527-9 (1949) July.

Studies on the translocation or accumulation of radio-phosphorus in mature corn plants with ripening ears are presented, and the procedure is described. The radioactive solution of P^{32} was put on the corn plants and samples were taken at intervals up to about 45 days later. After drying, and grinding, 0.1 gm samples were measured with a Geiger counter and the activity curves were plotted. The results show that the radioactive phosphorus increased rapidly in concentration in the plants until a maximum was reached after 12 days; the concentration then gradually decreased in each of the foliage parts to approximately the same value. The lower stems and leaves contained more P^{32} than those above the ears, and the leaves contained more than the stems. The concentration of P^{32} in the lower leaves and stems paralleled the concentrations in the upper parts of the plants; the P^{32} in the tassel increased slowly to a maximum. Husks contained more P^{32} than the cobs, and the concentration increased to a maximum, then declined. The phosphorus was almost translocated from the cob by the time the ear was ripe. The kernels contained the greatest concentration of all the tissues at the end of the experiment.

BIOLOGY AND MEDICINE (continued)

943 Radioactive sodium permeability and exchange in frog eggs. P. H. Abelson and W. R. Duryee. *Biol. Bull.* 96, 205-17(1949) June.

The results of an investigation undertaken to determine the quantity and speed of exchange of Na^{24} with normal sodium in a vertebrate frog are presented. In the course of the research a total of 20 experiments were performed involving the use of 400 selected eggs of the frog, Rana pipiens. The results show that the ovarian egg of the frog is freely permeable to Na^{24}, but only 12% of the sodium is very readily exchangeable. The sodium is distributed almost uniformly throughout the cytoplasm of the egg after only ½ hr; the nucleus possesses approximately twice as much traced sodium per volume as the cytoplasm. The diffusion coefficient of sodium within the egg is calculated, and it is concluded from the data that at least two different types of binding limit the internal diffusibility of sodium within the egg.

944 A study of the chemical origins of glycogen by use of C^{14}-labelled carbon dioxide, acetate, and pyruvate. Y. J. Topper and A. B. Hastings. *J. Biol. Chem.* 179, 1255-64(1949) July.

Quantitative data on the relative proportions of the glycogen carbons which were originally the carbons of pyruvate molecules are presented. Labelled glycogen was prepared by incubating rabbit liver slices in vitro in a potassium-rich medium with pyruvate as substrate in the presence of $C^{14}O$, CH_2, $CH_3C^{14}OOH$, or $CH_3C^{14}OCOOH$. It was found that in the presence of CH_3-$C^{14}OCOOH$, all the carbons of the glucose unit contained C^{14}. The experimental results demonstrate the symmetry of carbons 1, 2, and 3 of the glucose molecule with respect to carbons 6, 5, and 4. From the relative activities of the glucose carbons, the minimum number of labelled pyruvate molecules required to yield the experimental results has been estimated. The proportion of pyruvate molecules which are (a) phosphorylated directly, (b) equilibrated with symmetrical dicarboxylic acids before phosphorylation, and (c) converted to $C^{14}O_2$ which is then combined with pyruvate with the production of carboxyl-labelled pyruvate has been estimated. 12 references.

945 Thyroid collection of radioactive iodide and serum protein-bound iodine concentration in senescence, in hypothyroidism and in hypopituitarism by M. Perlmutter and D. S. Riggs *J. Clin Endocrinol* 9 430-439 (1949) May.

A study has been made of the rate of uptake of radioactive iodide by the thyroids of 160 apparently euthyroid and 13 hypothyroid or hypopituitary patients. The level of protein-bound iodine of the serum was determined in selected cases. A description of the method and technique of treatment is included. The rate of uptake of the isotope was determined by the method of Stanley and Astwood (Endocrinology 41, 66-84 (1947) July. One-tenth of a mc of carrier-free radioactive iodide in approximately 50 ml of water was administered to the patients orally about 30 min before breakfast or luncheon. A second 50 ml of water was administered immediately in order to wash down the radioactive isotope remaining in the mouth, glass, and esophagus. Counts, in duplicate, of the γ-radiation emanating from the neck were taken at intervals of 1, 2, 3, and 4 hr. The counts were then plotted and interpreted. The causes of a low rate of iodide uptake are discussed; there is considerable scatter of these uptakes within the euthyroid groups. The mean accumulation gradient, a measure of the rate of iodide uptake, decreases with aging, but in the male, there is a gradual drop in the mean gradient from puberty to senescence. In the female there is a sharp drop in the mean gradient, after the menopause, to low levels. The accumulation gradients tend to be low in hypothyroidism and in hypopituitarism; in these diseases, they are associated with a subnormal concentration of serum protein-bound iodine. A mechanism, whereby the peripheral tissue may regulate thyroid function, is postulated. It is concluded that the combined use of the rate of uptake of radioactive iodide and the assay of the circulating protein-bound iodine offers a valuable method for the study of abnormal metabolic states. 19 references and 7 tables.

CHEMISTRY

946 Comparison of colorimetric methods. Determination of color characteristics of some Corning filters and fluorescent cloths. L. R. Furlong. Naval Research Laboratory Report NRL-N-3256, Mar. 9, 1948. 21p.

Four color-measuring instruments, the Gaertner Monochromator, the General Electric recording spectrophotometer, the Donaldson trichromatic colorimeter, and the Nutting monochromatic colorimeter, are compared by determining the color characteristics of a number of Corning

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color filters and of four specimens of fluorescent cloth manufactured by the Continental Lithograph Company. Corning filters were employed because they are widely used commercially and knowledge of their color characteristics enables the determination of an unknown color by means of visual comparison with Corning filters. The fluorescent cloths were used primarily as a further evaluation of the instruments. Results show that for nonluminous samples the recording spectrophotometer and the trichromatic colorimeter are evenly matched with respect to accuracy, speed, and convenience; however, since the spectrophotometer is a nonvisual instrument the subjective error is reduced. This is an advantage in using the spectrophotometer rather than the trichromatic colorimeter. Both of these instruments surpass the monochromatic colorimeter in every respect except in simplicity of calculation. The Gaertner monochromator, rather than the recording spectrophotometer, was used to measure the color of luminous samples because the latter instrument cannot distinguish between reflection and fluorescence. The comparison between the nonvisual monochromator and the visual trichromatic colorimeter is the same as that between the spectrophotometer and the trichromatic colorimeter. For nonluminous substances the spectrophotometer was found to surpass the monochromator with respect to speed and convenience.

947 Gravimetric determination of thorium (A study of precipitates with the aid of the Chevenard thermobalance.) T. Dupuis and C. Duval. *Compt. rend. 228*, 401-2(1949) Jan. 31 (in French).

A comparative study was made of numerous methods of the quantitative determination of thorium, with the view to fix the optimal temperature conditions of the calcination of the precipitates. The results are presented in a table giving, for each precipitating reagent, the chemical nature of the precipitate and the recommended temperature limits for the drying and the calcination. Critical remarks are made on many of the known methods of thorium dosage.

948 Measurement techniques of applied radiochemistry. T. P. Kohman. *Analyt. Chem. 21*, 352-64(1949) Mar.

A survey is given of the more important practical techniques for the measurement of radioactivity and the principles on which they are based. The discussion is concerned primarily with the requirements for tracer work, in which only relative measurements are needed, but some attention is given to the problem of absolute measurements. Particular emphasis is accorded the types of errors encountered and their reduction and correction. Instrumental errors and uncertainties can generally be reduced to about 1%, and in some cases to about 0.1%, by application of properly determined corrections. Some original methods of determining corrections for nonlinearity of detectors are presented. 160 references.

949 The kinetics of the reaction of aluminum borohydride vapor with olefins. R. S. Brokaw. Princeton University Technical Paper No. 42 (Office of Naval Research Contract), Dec. 15, 1948. 16p. (NP-942).

The reactions between aluminum borohydride vapor, $Al(BH_4)_3$, and ethylene, C_2H_4, propylene, C_3H_8, and butene-1, C_4H_6, have been studied. The kinetics have been found to be first order with respect to the aluminum borohydride pressure and independent of the olefin concentration. The activation energy has been determined and a reaction mechanism is proposed. All three reactions occur at nearly the same rate. Boron alkyls are products of the reactions. The reactions are of interest in their bearing on the oxidation of the hydrocarbons induced by borohydride vapor.

950 Methods of separating and purifying radioisotopes. E. R. Tompkins. Isotopes Division Circular IDC-11, June 1948. 18p.

Radioisotopes formed by transmutation reactions or by fission are usually separated before being sent to the isotope user. Although the purest available sources of materials are used for the bombardment, they always contain some impurities. These will produce radioactive contaminants which (depending on their half-lives and radiation characteristics) may be of significance in the experimental work to be performed with the desired radioisotope. To insure reliable results, the target material must be purified before it is used. Methods discussed for this purpose include the following: coprecipitation, solvent extraction, distillation, electrodeposition, and ion-exchange. 23 references.

CHEMISTRY (continued)

951 Preparation of radioactive phosphate fertilizers. W. L. Hill, E. J. Fox, and J. F. Mullins. *Ind. Eng. Chem.* 41, 1328-34(1949) July.

The use of radioactive phosphorus as a tracer to determine the utilization of applied phosphate by growing plants promises, among other things, a means for comparing the efficiencies of different phosphates on fertile as well as infertile soils. Experiments of this type with fields planted last spring required 700 to 800 lb of radioactive fertilizer comprising five phosphate carriers. This requirement of active fertilizer necessitated the provision of special equipment in an isolated room—all dedicated to a single purpose for an indefinite period. Facilities were devised for the preparation of superphosphate, ammoniated superphosphate, dicalcium phosphate, α-tricalcium phosphate, and calcium metaphosphate glass with the intention of safeguarding the operators from the known health hazards.

952 Techniques for the synthesis and metabolic study of urethan (NH_2C^{14} Et). Howard E. Skipper, C. E. Bryan, and O. S. Hutchison. Isotopes Division Circular IDC-8 (Southern Research Institute), Sept., 1947. 12p.

As part of a broad, general study of compounds which may be useful in the treatment of cancer Southern Research Institute has investigated the syntheses and toxicity effects of a number of carbamates. This circular consists of descriptions of various aspects of the study of one of these compounds, ethyl carbamate (urethane) in which C^{14} is used as a radioactive tracer. The information contained in the circular is divided into three sections: (1) synthesis of ethyl carbamate (urethane) containing radioactive carbon, (2) a simple metabolism chamber for collecting respiratory carbon dioxide, and (3) oxidation of animal tissues for determination of radioactive carbon.

953 Equipment for radiochemical operations. E. R. Tompkins. Isotopes Division Circular IDA-6, June, 1948. 21p.

The complexity of the apparatus needed to make separations and perform other chemical operations involving radioactive substances will depend upon the level of activity and upon the nature of the chemical procedure selected. For separating microcurie quantities of these substances, it is possible to use standard chemical equipment and techniques. For very large quantities of radioisotopes it is necessary that all operations be carried out remotely. This objective may be achieved in one of two general ways: first, by fabricating devices which will make it possible for the operator to manipulate ordinary chemical equipment from behind a barrier and thus allow him to carry out the separation by techniques which are more or less standard, and, second, by adapting the techniques, already used widely by chemical engineers, of moving solutions and allowing the equipment to remain fixed. By combining the two, the manipulator may be constructed simply and inexpensively, and the separation apparatus built up as unit processes. General operations, apparatus for chemical procedures, apparatus for ion-exchange separation, and integration of separation apparatus are discussed.

954 The effect of cathode rays produced at 3,000 kilovolts on niacin tagged with C^{14}. S. A. Goldblith, B. E. Proctor, J. R. Hogness, and W. H. Langham. *J. Biol. Chem.* 179, 1163-7(1949) July.

In order to investigate the possibility that the destruction of niacin is due, at least in part, to decarboxylation, experiments were conducted in which niacin labelled with C^{14} in the carboxyl group was irradiated with cathode rays produced at 3,000 kv, and the effect of these radiations was measured by both chemical and radioactivity assays. When niacin in a concentration of 100 γ/ml was irradiated, decarboxylation to the extent of 28% occurred with as little as 0.17×10^6 rep (roentgen-equivalent-physical) of cathode rays, whereas splitting of the pyridine ring did not begin to occur until 0.66×10^6 rep of cathode rays had been applied. The rate of decarboxylation was increased with increments in dosage at lower levels but was less marked at dosages above 1.98×10^6 rep. Splitting of the pyridine ring appeared to require irradiation of greater magnitude than decarboxylation.

955 The effect of xenon ions in chemical action by alpha particles. S. C. Lind and M. Vanpee. *J. Phys. & Colloid Chem.* 53, 898-901(1949) June.

In earlier work on the influence of inert gases (S. C. Lind and D. C. Bardwell. *J. Am. Chem. Soc.* 48, 1575(1926)) in several reactions carried out under the ionizing influence of radon it was found that the chemical yield per ion pair (M/N) was independent of the nature of the gaseous ions, of which N is the total number causing M molecules to react. For example, in a

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mixture of acetylene with an inert gas such as argon, the rate and total yield depend on the total ionization produced by the α-particles in both acetylene and argon, not on that in acetylene alone. This important generalization was t sted for a number of other inert gases with the same result. Since xenon is now known to have an ionization potential lower than that of acetylene, the ionization produced by α-particles in a mixture of the two will pass by collision from xenon to acetylene. Hence xenon and acetylene cannot be used to prove that the nature of the ion is indifferent in causing the polymerization of acetylene to cuprene. Reactants with ionization higher than that of xenon must be used so as to produce xenon ions by exchange. Then if the reaction is accelerated instead of retarded the point will have been proved. Both hydrogen and oxygen have ionization potentials definitely above that of xenon. Therefore, the reaction $2H_2 + O_2 = 2H_2O$ is suitable to test the effect of xenon ions. Xenon ions in the proportion of 70-95% of the total ionization do cause this reaction to proceed about 12 times as fast as it would in the absence of xenon. The efficiency of the xenon ions in this range is about 50%. Xenon in the reaction $2CO + O_2 = 2CO_2$ shows a small positive effect. Xenon in the condensation of carbon monoxide to carbon suboxide by α-particles has no effect, either retarding or accelerating.

956 Further observations on the protection effect in radiation chemistry. W. M. Dale, J. V. Davies, and W. J. Meredith. *Brit. J. Cancer 3*, 31-41(1949) Mar.

Experiments are described on the following: (1) the variation of the ionic yield of solutions of carboxypeptidase, and of alloxazin-adenine-dinucleotide, irradiated by x-rays; (2) the specific protective action of unit mass of various solutes when irradiated (a) in the presence of carboxypeptidase (C.P.); and (b) in the presence of alloxazin-adenine-dinucleotide (D.N.); and (3) the variation of the protective power per unit mass of protector when the concentrations of protector and indicator are varied (phenomenon of the "changing quotient". The experiments are discussed and calculations are made using Weiss's (*Nature 153*, 748(1944)) explanation of the indirect action of ionizing radiations on aqueous solutions, i.e., that the action is attributable to the production by the radiation by hydrogen atoms and hydroxyl radicals in the water. From these it is concluded that the probability of a radical being destroyed when it collides with a D. N. molecule is 2.2 times as great as the corresponding probability for C. P. In the discussion of the experiments, a quantitative interpretation of the protective power of various substances in terms of collision frequencies is given, which includes the phenomenon of the "changing quotient."

957 Studies on the mechanism of action of ionizing radiations. II. Inhibition of sulfhydryl enzymes by alpha, beta, and gamma rays. E. S. Gunzman Barron and S. Dickman. *J. Gen. Physiol, 32*, 595-605(1949) May 20.

Experiments to determine the degree of inhibition delivered to two sulhydryl enzymes, phosphoglyceraldehyde dehydrogenase and urease, by α, β and γ-radiations are described. A buffered solution of polonium (0.57 mc/cc) was used to produce 180 r/day/cc of α-rays. The source of γ-radiations was a 1 g sample of radium enclosed in a brass tube, which delivered 4.5 r/min at a 5 cm distance. The results indicate that the activity of the two enzymes was decreased when dilute solutions were irradiated with the ray emitters. Partial reactivation of the enzymes by addition of glutathione was obtained after inhibition with α-rays. The evidence that these inhibitions are due to oxidation of the –SH groups of the enzymes was given by the irradiation of the mercury-mercaptide urease with γ-rays. This irradiated complex was completely reactivated by glutathione as was the non-irradiated enzyme. The ionic efficiency of all these ionizing radiations on inhibition of phosphoglyceraldehyde dehydrogenase was similar. 18 references.

958 A study of the process of oxidation (rusting) of iron with the aid of oxygen isotopes. E. I. Dontsova. *Doklady Akad. Nauk S. S. S. R. 63*, 305-6(1948) Nov. 21 (in Russian).

In the course of geochemical studies on the isotope content of oxygen in minerals, as a method for determining the genesis of rocks and minerals, the author made several experiments on the oxidation of iron in river water. The rusting took place in the presence of air containing various quantities of the isotope O^{18}. As a result it was found that water, not air, is the main source of oxygen in rust, and that the part played by the air oxygen in the process of rusting is that of a depolarizer.

959 Chemistry of the heavy elements. J. S. Anderson. *Nature 163*, 983-4(1949) June 25.

A symposium organized by the Chemistry Division of the Atomic Research Establishment, Harwell, on behalf of the Chemical Society, was held at Rhodes House, Oxford, during March

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28-30. One main topic of discussion was the chemistry of the heavy elements. The first session of the symposium was devoted to the elements other than uranium. The second session was devoted to the complex chemistry of uranyl solutions. Some of the topics discussed are as follows: review of the chemistry of the transuranic elements; the position of the cis-and transuranic elements in the periodic system; contributions to the chemistry of thorium and protoactinium; tracer chemistry of protoactinium solutions; measurements on ionization equilibria in uranyl nitrate and uranyl sulphate; complex compounds of uranium tetrachloride with tertiary alkyl phosphines; a paper on the lower oxides of uranium which revealed a complex system comparable with that of the oxides of molybdenum and tungsten; high temperature phase equilibria in the uranium-carbon and thorium-carbon systems were reviewed; the formation of hydrogen peroxide from water by the action of polonium α-rays; improved techniques for the determination of radon and radium in natural waters; and a new and highly selective method for the detection and determination of small amounts of uranium, based on the use of paper chromatography.

ENGINEERING

960 Radioactivity in pipe line flow studies. D. E. Hull, J. W. Kent, and R. D. Lee. *World Oil 129*, 187-8(1949) May.

The fluid flow in a pipe line was studied by using 10 mc of radioactive barium (Ba^{140}) in a dilute solution of hydrochloric acid. This solution was converted to an oil soluble barium soap which was dissolved in a small quantity of oil. The preparation was then injected into a crude stream in a 20-in. pipe line on the upstream side of a centrifugal pump. Detection of the presence of radioactivity was accomplished with a portable Geiger counter equipped with earphones. The decay scheme of radiactive barium is given below.

$$Ba^{140} \xrightarrow[\text{in 12.8 days}]{\text{50\% decay}} La^{140} \xrightarrow[\text{in 40 hours}]{\text{50\% decay}} Ce^{140}\ \text{(stable)}$$

By this radioactive technique a practical method is provided for obtaining valuable information on the location, flow, velocity, and degree of intermixing of stocks in a pipe line.

MINERALOGY, METALLURGY AND CERAMICS

961 Twenty-sixth annual meeting of the Ametican Institute of Chemists. *The Chemist 26*, 219-31(1949) June.

This is a short report on the proceedings of the Annual Meeting of the American Institute of Chemists, in Chicago, May 6 and 7, 1949. Several abstracts are given of papers presented at the meeting. The following are concerned with nuclear processes and radioactivity: Age determination by radiocarbon content: world-wide assay of natural radiocarbon, by W. F. Libby; Nuclear processes in the atmosphere, by J. A. Simpson, Jr.; The measurement of temperature of oceans of past geological ages, by H. C. Urey; Some applications of scintillating crystals in the field of x-ray and radioactive materials, by R. J. Moon.

962 Allotropic transformations in titanium. A. D. McQuillan. *Nature 164*, 24(1949) July 2 (Letter to the editor).

Pure titanium metal prepared by the dissociation of titanium tetraiodide undergoes an allotropic change in the temperature range 860° - 900°C. Titanium has a hexagonal close-packed structure below 800°C and a body-centered cubic structure above 900°C. It now appears that there are two distinct transformations, one at 864°C and another at 900°C and that a third allotropic modification of titanium is stable between these temperatures. The equation for the heat of solution of hydrogen in titanium metal is given and a curve showing the variation of equilibrium hydrogen pressure with temperature for a solution of 0.02 atomic per cent hydrogen in 99.9% titanium metal is included. From these results the transformations of α and β titanium are discussed.

963 Geiger counter technique for x-ray diffraction. Part II. A method of determining thicknesses of thin coatings. H. Friedman and L. S. Birks. Naval Research Laboratory Report NRL-H-2246, Feb. 28, 1944. 10p. (See also Nuclear Science Abstract 3-441).

The report describes a method of adapting x-ray transmission for measuring thin coating or plating thicknesses from one side. It is essentially non-destructive; it measures non-metallic or metallic coatings on either type of backing; it determines separate thicknesses in multi-layer coatings of different substances; it measures mass per unit area independently of backing surface or front surface roughness; a single measurement may be an average over a surface area as large as one square inch or as small as one-quarter square millimeter; external surfaces of almost any shape may be handled; when supplemented by electron microscope information, the thickness of coatings on small particles in the pigment range can be estimated. In addition the effects of general and fluorescent scattered radiation and methods of measuring thickness of platings are discussed.

964 Geiger counter technique for x-ray diffraction. Part III. Particle size determination from x-ray line broadening. L. S. Birks. Naval Research Laboratory Report NRL-H-2434, Dec. 1, 1944. 33p. (See also Nuclear Science Abstract 3-441).

The x-ray diffraction line broadening method of determining particle size was compared with direct measurement in the electron microscope. By controlling temperatures and heating periods, magnesium oxide particles were prepared from 50-1000 A. Sizes calculated from x-ray data taken on the N.R.L. Geiger counter spectrometer agreed to ± 10% with the microscope measurements. Qualitative results were obtained on specimens containing a wide range of particle sizes.

965 Geiger counter technique for x-ray diffraction. Part IV. Detailed consideration of experimental conditions. L. S. Birks. Naval Research Laboratory Report NRL-H-2517, Apr. 20, 1945. 52p. (See also Nuclear Science Abstract 3-441).

Consideration has been given to the conditions affecting the results of x-ray powder diffraction with the Geiger counter. Some of the conclusions follow: A flat specimen up to 2 cm in length is a satisfactory approximation to the arc of the focusing circle for routine powder identification. Specimens curved for a particular value of 2θ may be extended up to 10 cm with no effect on line shape or position. No "absorption correction factor" is involved when the specimen rotates at half the speed of the counter. The dimensions of the counter slit have relatively small effect on the line position but do affect the line width. The amount of divergence has no effect on line shape or position as long as the specimen is a sufficiently accurate approximation to the arc of the focusing circle. For source to specimen distance of less than 15 cm, the source slit height should be limited to 5 mm in order not to introduce asymmetry into

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the line shape. The line width at half maximum is a linear fraction of source width up to a source width of 2mm. Any tilting of the specimen so that the face is not normal to the plane of the spectrometer causes appreciable asymmetry in the line shape. The face should be normal within 2 degrees. The specimen surface may lie outside or inside the focusing circle by as much as .5 mm without changing the line width by more than 3 min. Special precautions are necessary for specimens where the particles tend to orient. The precuations take two forms: (1) the particles may be prevented from orienting by loose packing, diluting, or sprinkling the material on a slide; (2) the particle shapes may be changed by prolonged grinding so that they no longer tend to orient. Breaking up the particles by grinding was shown to be the better method when applicable. A low background intensity is obtained over the whole range of the spectrometer due to the decreased efficiency of the Geiger counter for the shorter wavelengths of the continuous spectrum. Automatic scanning and recording of the pattern gives satisfactory results. A speed of 5 degrees/min is useful for most identification work. Slower speeds such as 1/4 degree/min reduce the background variation when very weak lines are to be recorded.

966 Why metals corrode. H. H. Uhlig. *Corrosion 5*, 169-74(1949) July.

The author discusses the mechanism of metal corrosion by cell action. Three types of cells are mentioned. They are (1) dissimilar electrode cells, (2) dissimilar electrolyte cells which are further divided into (a) differential aeration cells and (b) salt concentration cells, and (3) dissimilar temperature cells (thermogalvenic cells). In conjunction with the above the following main headings are described: corrosion tendencies of metals; corrosion and hydrogen overvoltage; depolarization; action of bacteria; effect of oxygen concentration; and surface corrosion products. Methods of controlling corrosion are briefly presented.

967 Zirconium metal, as of 1949 - Iodide -, magnesium-reduced, and calcium-reduced Zr. R. I. Jaffee. *J. Metals 1*, 6-9(1949) July (See also Nuclear Science Abstract 1-1622).

Three kinds of malleable zirconium which are available commercially or are in the developmental stages are discussed: (1) iodide zirconium which is made by the thermal decomposition of zirconium iodide on a hot filament (manufactured by the Foote Mineral Co.); (2) magnesium-reduced zirconium, made by the Kroll process of reacting molten magnesium with zirconium chloride (produced on a rather large-scale pilot plant by the Bureau of Mines); (3) calcium-reduced zirconium, made by reduction of zirconium oxide with calcium (process being developed by the Westinghouse Company).The effect on the cold malleability of zirconium when oxygen, nitrogen, and hydrogen are present in solid solution is discussed and a table listing the mechanical properties of the metal under different conditions is presented. A table listing the physical properties of zirconium is included.

968 Development of uranium deposits at Mount Painter, S. A. [South Australia]. *Chem. Eng. Mining Rev. 41*, No. 3, 85-8(1948) Dec. 10.

Uranium deposits were discovered near Mount Painter in 1910 and the area was worked intermittently for radium until 1934. Exploratory work was resumed in 1944, and has been carried on more intensively since 1946. The area being examined (about 150 sq miles) is 300 miles north of Adelaide and 60 miles east of Copley. The uranium-bearing deposits of Mount Painter are similar to those in Portugal and Bulgaria where primary uranium minerals are disseminated through granite and pegmatite and have given rise to secondary enrichments.

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969 Calculation of the range of protons in substances made of light elements. R. Glocker. *Z. Angew. Physik 1*, 179-81(1948) Sept. (in German).

An approximate formula is derived giving the proton range in substances composed of atoms of low atomic weight. A comparison is made with the exact values found for paraffin and glycerol tristearate by Hirschfelder and Magee (*Phys. Rev. 73*, 207(1948)). Ranges in air, water, and organic tissues are calculated with a view of possible applications in radiology.

970 Ejection of electrons from a metal by fast alpha particles. H. E. Kee, Jr. Ohio State University, 1947. 48p. (NP-917).

A thesis is presented on the ejection of electrons from a metal by fast alpha particles. Electrons ejected from a metal at an angle of 71°30′ have been examined. This examination was made possible by the construction of an apparatus in such a manner that every electron

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collected came from the metal at an angle of 71° 30' ± 30' without regard to the direction of the incident alpha. The theory of the shape of this scattering surface is discussed in detail, both as regards the geometry of the apparatus and the collision theory. The experimental work conducted in this thesis indicates that multiple scattering predominates over single scattering to such an extent that the number of singly scattered electrons collected are not sufficient to be detectable.

971 Nuclear shielding studies. II. Gamma ray ionization in spherical geometry. J. S. Levin, J. W. Weil, and C. Goodman. MIT Laboratory for Nuclear Science and Engineering Technical Report No. 22 (Office of Naval Research Contract), June 15, 1949. 55p. (NP-875).

Measurements were made of gamma-ray ionization intensity at distances of from 18 to 63 cm from a point source located in a sphere immersed in water and filled with various absorbing materials. Two sources were used, a one-gram Ra-Be gamma-ray and neutron source and a two-curie Co^{60} gamma-ray source. Measurements were made with air, water, Fe shot, and Pb shot in the sphere for the Ra-Be source and with water and Pb shot in the sphere for the C^{60} source. Resultant distributions were plotted with the square of the distance from the source times the ionization intensity as a function of distance from the source. Absorption coefficients for the essentially linear portion of the curve beyond 43 cm were calculated. For most materials in the sphere the absorption coefficient of the emergent gamma rays in water appeared to be about the same. Pb, however, showed other effects, some of which were attributable in the case of the Ra-Be source to the presence of the neutrons from this source. All curves showed divergence from the simple exponential absorption law.

972 Theoretical study of electromagnetic waves scattered from shaped metal surfaces. W. W. Hansen and L. I. Schiff. Stanford University Quarterly Report No. 4 (Final Report), Sept. 30, 1948. 25p. (NP-916).

A final interim report is submitted on the theoretical study of electromagnetic waves scattered fromshaped metal surfaces. The scattering from objects that present no specularly reflecting surface was especially difficult to estimate theoretically; therefore that effort was concentrated on obtaining solutions for those shapes for which the vector wave equation is separable. Complete and exact analytical solutions were given for the scattering by a perfectly conducting semi-infinite wedge when the radiation is incident to the axis of the wedge and is polarized both perpendicularly and parallel to the edge. A qualitative physical argument was given for the validity of a result proven analytically that the width of the penumbral transition from light to darkness along a smooth surface of a given radius of curvature has a corresponding functional magnitude.

973 Cascade curves for lead. G. T. Zatsepin. *Doklady Akad. Nauk S.S.S.R.* 69, 243-6(1948) Nov. 21 (in Russian).

The theory of cascades given by Belenkii (Avalanche processes in cosmic rays, Moscow-Leningrad, 1948) contains certain magnitudes involving the total number of charged particles at a given depth, the energy of the shower-producing primary particle, and the ionization losses. The present author calculated the values of these magnitudes for the case of lead, from which the corresponding cascade curves were constructed. It was found that the value of the penetrating power of electron-photon avalanches in lead must be higher than those usually given.

974 Distribution of penetrating particles and high energy electrons in extensive atmospheric showers. D. M. Alekseev, G. T. Zatsepin, and I. G. Morozov. *Doklady Akad. Nauk S.S.S.R.* 69, 375-7(1948) Dec. 1 (in Russian).

The identification of extensive atmospheric showers with the electron-photon showers of the cascade theory is doubted in the light of recent observations, the principal anomalies being the presence of large quantities of penetrating particles and the wide extension of the shower. The authors submitted these facts to a closer study, by screening, at 3,860 m altitude, penetrating particles traversing 24 cm of lead from high energy electrons and photons traversing 12 cm of Pb. The distance between groups of counters varied between 2 and 60 m. The measurements showed that the electron-photon component had a mean extension of about 20 m, which is far in excess of the value 2.4 m for the mean square root radius of a shower of cascade particles traversing a 12 cm lead filter, according to Belenkii's treatment of the

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cascade theory (*Zhur. Eksptl. i Teoret. Fiz. 14*, 384(1944)). The evaluation of the extension of the penetrating component can be obtained by comparing measurements taken with and without Pb filters. By combining their own results with those obtained by Auger, et al. (*Compt. Rend. 208*, 1641(1939)), the authors found that the extension of the penetrating particles exceeds that of the electron component. This points to the atmospheric origin of the penetrating component, contrary to the opinion of several authors who locate their origin in the Pb, (Salvini and Tagliaferri, *Phys. Rev. 73*, 261(1938); Broadbent and Janossy, *Proc. Roy. Soc. (London) 192*, 368(1948)).

975 Nuclear interactions of the particles produced in cosmic ray bursts. A. Lovati, A. Mura, G. Salvini, and G. Tagliaferri. *Nature 163*, 1004-6(1949) June 25.

The authors report the preliminary results of an investigation to study nuclear bursts carried out with a counter-controlled cloud chamber at the Laboratorio della Testa Grigia (3,500 m). The equipment is described. Eight hundred and one photographs were obtained in 205 hr. In the absorption measurements of the radiation which produces nuclear disintegrations, a large percentage of the stars and bursts are produced by the secondaries generated in the absorbers. A discussion of the scattering of the penetrating particles of the bursts is also presented. A mean cross section for the production of new bursts was obtained and is given below:

$$\sigma = \frac{6}{380 \times 1.2 \times n} \frac{1}{p} = \frac{4 \times 10^{-25}}{p} \text{ cm}^2 \text{ per nucleus,}$$

where n is the number of Pb nuclei /cm^3, and p is the mean probability that a burst produced within the plate may still appear in the cloud chamber with heavily ionizing particles.

976 Observation of nuclear disintegrations below ground. J. Evans and E. P. George. *Nature 164*, 20(1949) July 2 (Letter to the editor).

Ilford Nuclear Research photographic plates were stored vertically in an underground laboratory. The laboratory is at a depth of 30 m under London clay. After 60 days, the plates were developed and six nuclear disintegrations containing three or more tracks were noticed. The rate of production of these stars at this depth is 0.01 ± 0.004 stars/cc/day. At sea level 1.5 ± 0.07 stars/cc/day are observed. It is assumed that the underground stars are produced by a radiation differing from that producing the above ground stars. The underground stars are assumed to be secondary in some way to the penetrating component of cosmic radiation, the μ-mesons. One possible mechanism for the production of the stars is that a μ-meson is scattered by a nucleon, the recoil momentum of the latter being sufficiently large to cause the disintegration of the parent nucleus. The cross section per nucleon for this process would then have to be: $\sigma\mu = 0.5 \times 10^{-28}$ cm^2. Alternative explanations which must be considered are that the stars are caused by (1) the electrons or photons that are produced underground by the μ-mesons, (2) neutral particles that may be produced locally by the μ-meson, or in the atmosphere by energetic primary particles, and then have penetrated underground. If the stars are produced by the soft component, then this would require an average cross-section of $\sigma\mu = 7 \times 10^{-26}$ cm^2 for the photo or electro-disintegration of nuclei, and this does not appear to be very likely.

977 On disintegrating particles in the cosmic rays of the stratosphere. L. T. Baradzeĭ, S. N. Vernov, and Y. A. Smorodin. *Doklady Akad. Nauk S.S.S.R. 63*, 233-4(1948) Nov. 21 (in Russian).

Stratospheric measurements of the intensity of the penetrating component of cosmic radiation were made, the angles α, formed by the rays and the vertical, being equal to 0° and 60°. The intensities for these two angles, and the differences of the two intensities, were plotted against $p/\cos\alpha$ g/cm^2, i.e., against the thickness of the layer of matter traversed by the radiation. The difference curve has a maximum at 120 g/cm^2. This curve represents the differences between the numbers of mesons disintegrating above the observation point. At the altitude corresponding to the maximum, this quantity is about 30% of the intensity of the penetrating radiation. Below this point, mesons probably form a considerable fraction of the penetrating component.

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978 Structure of cosmic-ray showers. J. R. Prescott and C. B. O. Mohr. *Nature 164*, 21-2(1949) July 2 (Letter to the editor).

The lateral distribution function of extensive cosmic-ray showers was investigated with two ionization chambers in coincidence at sea level. A complete description of the chambers is given. The observations were carried out between December, 1947, and September, 1948, and covered about 1,600 hr. A graph is shown giving the coincidence-rate as a function of chamber separation. The chambers were covered with 0, 0.5, and 1 cm of Pb respectively, and the corresponding curves are included in the graph. The air-lead transition curves for a single chamber include bursts due to both disintegrations and showers. "It should be noted that while about half the bursts observed in our chambers are due to disintegrations and the remainder to showers, Bridge, Hazen, Rossi, and Williams (*Phys. Rev. 74*, 1083(1948)), using the same chambers as Williams at 3,500 m, attribute 98% of their single-chamber bursts to disintegrations. Their higher proportion of disintegrations could be attributed to the use of a gas pressure one-eighth of that in our chambers and to the use of argon instead of nitrogen. It appears that the only reliable method of measuring extensive shower-rates for showers of a given density is to use coincidence chambers sufficiently far apart to avoid recording narrow showers or disintegrations. Our rate for extensive showers of density greater than 600 particles per sq m is 0.06/hr, which is ten times the rate predicted by Wolfenstein (*Phys. Rev. 67*, 238(1945)). The rates obtained by Lewis and by Williams (*Phys. Rev. 67*, 228(1945); *74*, 1689(1948)) at the higher altitude for a chamber separation of 10 meters and for showers of the same density are also much greater than the predicted rate, by factors of 280 and 12, respectively. Part of the discrepancy may well be attributed to Wolfenstein's inclusion of the zenith angle effect, whereas recent experiments (*Phys. Rev. 74*, 1869(1948)) indicate that extensive showers penetrating to the lower altitudes are incident nearly vertically."

979 Transition effect in lead of star-producing radiation. G. Cortini and A. Manfredini. *Nature 163*, 991-2(1949) June 25 (Letter to the editor).

Data is given which affirms that the transition effect in lead really exists. It is produced almost entirely by the three-prong stars. The data is insufficient yet to give an idea about the secondary radiation responsible for the stars.

980 Varitrons. *Priroda*, No. 1, 59-62(1949) Jan. (in Russian).

This article outlines basic Soviet research in the mass and charge of new particles of cosmic radiation. Varitrons are particles having varying masses from 110 to 20,000 times that of the electron, and are either positively or negatively charged, both charge and mass being determined under a variety of experimental conditions. Varitrons with a mass of 200 times that of the electron have a life in the order of 2×10^{-6} seconds. The article indicates that further investigation of the varitron is of great importance in cosmic ray research and in atomic structure and nuclear forces.

981 Improved sectioning technique for electron microscopy. R. F. Baker and D. C. Pease. *J. Applied Phys. 20*, 480(1949) May (Letter to the editor).

Improvements have been made during the past year on the microtome, making it possible to cut and mount 0.05-micron sections for electron microscopy. The sections cut by old equipment were 0.2-micron thick. The new developments and operation of the equipment are described.

982 Magnet coils. L. G. Coonrod, W. E. Cecconi, C. Gedraitis, K. R. Harper, and R. M. Lewis. *Rev. Sci. Instruments 20*, 408-10(1949) June.

Methods of winding magnet coils using copper tape as the current-carrying element are described. The methods were developed over a period of time during the construction of magnet and Helmholtz coils to be used in the production of magnetic fields varying from 1,700 to 17,000 gauss which were used in the Laboratory for Nuclear Science and Engineering at M.I.T. Difficulties with unsatisfactory arrangements are pointed out. One satisfactory system is described in detail, which provides an efficient design for magnet winding (to yield a relatively high copper cross section) while permitting the removal of heat at a high rate.

983 On the velocity-dependent characteristics of high frequency tubes. J. K. Knipp. *J. Applied Phys. 20* 425-31(1949) May.

The electronic transadmittances, transmodulation functions, and other characteristics of a planar, multigrid high frequency tube are expressed in terms of four fundamental admittance

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and modulation functions which are sufficient for the description of the low level r-f properties of the electron beam. A matrix representation is introduced based on the successive velocity moments of the beam which leads to the formulation of the characteristics as products involving excitation, grid transmission, mudulation, and modulation admittance matrices. The electronic equations obtained are a formulation in which the Llewellyn approximation that the second and all higher velocity moments are zero is not made. Thus the theory allows for higher order velocity effects but is dependent on the knowledge of the fundamental admittance and modulation functions.

984 Phase contrast in electron microscope images. E. G. Ramberg. *J. Applied Phys. 20*, 441-4(1949) May.

Image contrast in electron microscope images may arise from absorption, scattering, or phase changes impressed on the illuminating electron wave. In the present paper the intensity distribution in the in-focus and out-of-focus image of an edge of a transparent thin film introducing a prescribed phase change in the incident beam is calculated. It is found that the resulting "phase contrast" increases both with the film thickness (i.e., magnitude of phase change) and with the degree of defocusing and, for thin specimens, exceeds other sources of contrast in magnitude. The model is too schematic to permit a quantitative comparison with measured intensity distributions.

985 An apparatus for measuring the energies of fission fragments obtained by slow and fast neutron bombardment. L. Simons and B. Grotenfelt. *Soc. Sci. Fennica Commentationes Phys. Math. 13*, No. 9(1948). 9p.

The apparatus described and illustrated by the authors comprises a parallel-plate ionization chamber, an amplifier, a calibration impulse generator, a thyratron stage, a mechanical recorder, a cathode oscillograph, a storage battery for the heaters, a miniature cascade generator for the ionization chamber voltage power supply for various stages, and a water-tank neutron moderator.

986 Experiments with monochromatic slow neutrons. N. A. Ulasov. *Uspekhi Fiz. Nauk 35*, No. 3, 352-83(1948); No. 4, 369-513(1948) (in Russian).

This article describes: (1) mechanical selectors and the development of their application during the period 1936-1948; (2) the structure of selector-modulators and detectors; (3) synchronizing systems; (4) the spectra of slow neutrons; (5) the absorption and dispersion of neutrons in B, Li, and Cd, and resonance absorption in other elements such as In, Ag, Au, Mn, Sb, I, Hg, Ir, Ta, W, Pt, Zr, Os, Co, Th, Cb, Ge, Gd, and Dy. The investigation, carried out by means of selectors, of the interaction between neutrons and matter covers the energy range from 10^{-3} ev to nearly 1000 ev. This range comprises all slow neutrons and, in particular, the thermal ones which play the decisive role in systems with self-developing chain reactions of fission of heavy nuclei. The experimentation with selectors helped to prove the resonance character of the interaction of slow neutrons and nuclei. The width of the nuclear layer has been measured with the precision of one one-thousandth as a result of these experiments. No other method could permit such a detailed investigation of the nuclear states. The processes of interference of neutron waves, which is caused by either the molecular or the crystal structure of the matter, could be clearly observed and studied by means of selectors. A medium-sized cyclotron has been used as a source of neutrons. Selectors have been used also for studying the interaction of neutrons and electrons. The author asserts that the field of application of selectors will increase when more material for the investigated energies are available. The article includes 60 graphs.

987 High energy neutron-proton scattering and the meson theory of nuclear forces with strong coupling. J. L. Lopes. *Summa Brasil. Phys. 1*, (1947) May. 47p.

In this work the anisotropy of the scattering of 14-Mev neutrons by protons is investigated using the meson field theory of nuclear forces with the scheme proposed by Moller and Rosenfeld involving the strong coupling limit and the symmetrical form. In the second Born's approximation, the virtual excited states (isobars) of the nucleons decrease the ratio R of the differential cross sections in the backward and perpendicular directions (in the center of mass system); R also decreases with the isobar energy. However, R is still larger than 1 and the

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results suggest the possibility that the combined effects of the virtual isobars and the tensor force might give a forward scattering in agreement with Amaldi's experiments. In the second Part the total cross section of the inelastic scattering of 100-200-Mev neutrons by protons with production of isobars is investigated using the Moller-Rosenfeld, pseudoscalar, and Schwinger theories (in first Born's approximation). The total cross section is of the order of 10^{-26} cm^2, and its ratio to the elastic cross section is determined for 100-Mev bombarding neutrons; the isobar energy assumed is 45 Mev. An experiment to detect the isobars would be crucial for a decision between the assumptions of the weak coupling and strong coupling theories.

988 On the elastic scattering of neutrons by deuterons. M. Verde. *Helv. Phys. Acta 22*, 339-60(1949) June 30.

The purpose of this paper is to present a theory of the n-d scattering. The three main results are: (1) rigorous treatment of spin and isotopic spin; (2) the generalization of the well known integral form for the scattering phases for the case of three particles; (3) the extension of the variational method for the calculation of these phases, which has already been successfully applied by Hulthen (*Kgl. Fys. Lund 14*, 8(1944)) for the two-body problem. Inspection of these exact integral formulas allows one to draw conclusions about the exchange nature of the forces. A detailed comparison with experiment is unfortunately not possible because the experimental results on n-d scattering are rather poor. On the other hand, those for p-d scattering are excellent, and a theoretical investigation of this more complicated problem is now under way.

989 On the non-electromagnetic interactions between electrons and neutrons. A. Akhiezer and I. Pomeranchuk. *Zhur. Eksptl i Teoret. Fiz. 19*, 558-9(1949) June (in Russian) (Letter to the editor).

The asymmetry of the scattering of neutrons in xenon was attributed by Fermi and Marshall (*Phys. Rev. 72*, 1139(1947)) to a non-electromagnetic interaction between neutrons and electrons. However, the observed asymmetry may also be caused by the interference of waves scattered by the gas atoms. This interference is due to a correlation in the mutual arrangement of the atoms, which is determined by the fact that the distance between the centers of two atoms cannot be less than two atomic radii. Being proportional to the gas density, the interference effect is small at pressures of the order of magnitude of 1 atm, employed by Fermi and Marshall; however, the effect described by these authors is also very small. It is shown in the present note that the interference effect must be of the order of magnitude of the effect observed.

990 Stochastic (Monte Carlo) attenuation analysis. H. Kahn. RAND Corporation Report RAND-P-88 (rev), July 14, 1949. 22p.

The discussion concerns the application of random sampling techniques to the problem of neutron and gamma ray attenuation in thick shields. In such an analysis, deductions about the behavior of a large number of neutrons are made from a study of comparatively few. The nature of random sampling, random sampling as an analogue device, improvements over the straight analogue device, integration by random sampling, exponential transformation, quota sampling, parametric studies, splitting, and statistical estimation are discussed.

991 Nuclear shell structure. E. Feenberg and K. C. Hammack. *Phys. Rev. 75*, 1877-93 (1949) June 15. (See also Nuclear Science Abstract 2-1092).

The existence of closed shells in nuclei is indicated by the particular stability and abundance of nuclear systems with certain numbers of neutrons and of protons. A correspondence exists between these numbers and the degeneracy of energy levels in the model of free particles in a simple rectangular potential well. The empirical relations suggest the addition of a central depression to the well for light nuclei (N or $Z \leqq 20$) and a central elevation (Elsasser's wine bottle potential), (*J. Phys. radium 5*, 625(1934)), for heavy nuclei. The qualitative physical explanation of these modifications is that for light nuclei the particle density, and thus the nuclear interaction energy, is greatest at the center of the nucleus; for heavy nuclei, the Coulomb repulsion between protons produces a particle density varying from a minimum at the center to a maximum near the boundary and, therefore, a similarly varying interaction energy. In the free particle model, levels with small angular momentum and nodes within the nucleus are displaced upward by the central elevation and crossing of levels in the desired direction occurs, though not exactly as required to explain the complete empirical list of closed

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shell numbers. It is apparent that a single particle model of the nucleus is an insufficient approximation; however, qualitative arguments based on configuration interaction enable one to formulate, with little ambiguity, a shell model in agreement with the empirical facts. Experimentally known spins, magnetic moments and quadrupole moments of nuclei with a small number of particles outside of closed shells, or missing from closed shells, tend to corroborate the model. The agreement is particularly good for odd nuclei with one kind of nucleon forming a closed shell ± one particle (and better still if the even group of nucleons constitutes a closed shell). Under these conditions, the orbit of the odd particle, as given by the shell model, usually determines the state of the nucleus, which is checked for consistency with the known spins and moments. In some cases, the reasoning is reversed as a means of fixing the cross-over points between energy levels in the theory. Islands of isomerism appear in a table of odd nuclei arranged according to the odd member of the pair N, Z. Since isomerism occurs when large spin differences exist between the ground state and the excited state, the correlation of isomerism with the crossing or close spacing of energy levels in the shell model is readily seen. Possible paired configurations representing ground state and isomeric state are assigned to various isomeric transitions. Spins and moments (where known), and parity relationships given by Wiedenbeck's plot of half-life vs energy (*Phys. Rev. 69*, 567(1946)), are used to determine the preferred configurations and to clarify the details of the shell model. β-decay transitions are classified empirically into allowed and forbidden categories on the basis of calculated f-t values. The configurations of parent and daughter nuclei, as given by the shell model, determine the parity and range of possible spin values for each. Using the Gamow-Teller selection rules, the consistency of the allowed or forbidden empirical classification with the possibilities of the shell model are investigated. In many cases the ambiguity of spin in the parent or daughter nucleus is lessened. The empirical transition classification breaks down in several cases, chiefly those in which transitions that are theoretically first forbidden ($\Delta I = \pm 2$, change in parity) have f-t values that place them in the empirical second forbidden category, indicating a very small nuclear matrix element. An extensive table of allowed (unfavored) transitions shows no trend of f-t with atomic mass over the range $19 \leq A \leq 140$.

992 On closed shells in nuclei. II. M. G. Mayer. *Phys. Rev. 75*, 1969-70(1949) June 15 (Letter to the editor)(See also *Nuclear Science Abstract 1*-803).

A scheme for nuclear shell models is proposed which follows the order in a potential well and achieves the breaks at the correct places by the assumption of a strong spin-orbit coupling which increases with the angular momentum. The results obtained are shown in tabular form; the square well potential levels, spectral terms, spin terms, number of states, and number of shells are included. Another table lists the known spin and orbital assignments from magnetic moments (when these are known and unambiguous) for the even-odd nuclei having Z-values up to 83. The scheme obtained is compared with those previously reported by Feeberg and Hammack(*Phys. Rev. 75*, 1877(1949) and Nordheim (*Phys. Rev. 75*, 1894(1949)).

993 On the "Magic Numbers" in nuclear structure. O. Haxel, J. H. D. Jensen, and H. E. Suess. *Phys. Rev. 75*, 1766(1949) June 1,(Letter to the editor).

A tabulated classification of nuclear states is discussed and it is demonstrated that a simple explanation of the "magic numbers" 14, 28, 50, 82, and 126 follows at once from the oscillator model of the nucleus (Bethe and Bacher, *Revs. Modern Phys. 8*, 82(1937)), if it is assumed that the spin-orbit coupling in the Yukawa field theory of nuclear forces leads to a strong splitting of a term with angular momentum "l" into two distinct terms $j = l \pm 1/2$.

994 Investigation of protons formed during the bombardment of magnesium by deuterons. Y. A. Nemilov and L. I. Gedeonov. *Doklady Akad. Nauk S.S.S.R. 63*, 115-8(1948) Nov. 11 (in Russian).

Energy of protons produced by a deuteron bombardment of magnesium was measured using a wedge-shaped Al filter placed in front of a photographic plate. The step-like form of the darkening curve showed that the protons had several discrete energy values. These were determined from the thicknesses of the filter at points corresponding to the edges of each step of the curve. The darkening in each step gave the relative intensity of protons belonging to that step. The energy of the bombarding deuterons was 3.9 Mev, the Mg target was 2-3 μ thick, the angle between the proton rays used and the deuteron rays was 130-150°. The following results were obtained: (1) energies: 7.74 ± 0.12, 7.09 ± 0.14, 6.11 ± 0.12, 5.57 ± 0.11,

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4.93 ± 0.10, 3.94 ± 0.15 Mev; (2) relative intensities corresponding to the first five energy values: 1, 2, 1.5, 3.5, 27. The last (sixth) energy value belongs to deuterons elastically scattered by the material of the target support. The value 4.93 Mev is due to the reaction $O^{16}(d,p)O^{17}$, involving oxygen contained in the target. The remaining four energy values should be attributed to the reaction $Mg^{24}(d,p)Mg^{25}$ involving the most abundant isotope Mg^{24} only, rather than Mg^{25} and Mg^{26} also. On this assumption, the four values represent the ground state energy (approximation ± 0.30 Mev) and three excited levels of the Mg^{25} nucleus with the corresponding energies 0.70 ± 0.27, 1.70 ± 0.26, and 2.25 ± 0.25 Mev. These values agree with the data of Pollard et al, (*Bull. Am. Phys. Soc.* 29, No. 3(1948)) and of McMillan and Lawrence (*Phys. Rev.* 47, 343(1935)).

995 Research in nuclear reactions with fast alpha particles, deuterons, and neutrons and a study of the structure of complex nuclei. Purdue University Technical Report No. III (Office of Naval Research Contract), June 1, 1949, 65p. (NP-943).

The following subjects are discussed: the absolute cross section of the (α, n) reaction with Ag, by D. M. Roberts; the decay schemes of In^{110} and of the isomeric pair In^{112}, by S. A. Chowdary; the disintegration energy of Al^{29}, by L. Seidlity, E. Bleuler, and D. J. Tendam; energy spectrum of the Be + D – neutrons, by O. Gailar and E. Bleuler; stopping power of Ge and Si for high energy deuterons, by T. H. Heller and D. J. Tendam; and fluorescence of anthracene excited by high energy radiations by L. Roth.

996 The development of the linear accelerator. W. Graffunder. *Helv. Phys. Acta*, 22, 233-60(1949) June 30 (in German).

This is a review of works on the linear accelerator. Thirty-two references are given. The paper treats the acceleration of electrons in single resonators of various shapes (cylinder, box, sphere, double cone) and in wave guides. The discussion of this latter case is subdivided as follows: the field equations of a E_{01} wave, the field intensity, the transfer of energy to the electrons, and the effect of geometrically similar changes in the dimensions of the accelerator.

997 Radiation pressure of centimetre waves. N. Carrara and P. Lombardini. *Nature* 163, 171(1949) Jan. 29 (letter to the editor).

Using a 725 A. -type magnetron generating bursts of radio-frequency energy ($\lambda = 3$ cm, duration of each burst 1 μ sec with a recurrence of 1,000 cycles/sec) of a mean value of 50 watts, the pressure exerted by the energy impinging on a surface of 2 cm^2 (cross section of rectangular wave guide) is of the order of 10^{-2} dyne/cm^2. In order to detect such a pressure the aluminium blade (6 cm^2 cross-section) of a symmetrical torsion balance, having an arm 2 cm long, protected by a glass cover was placed before the mouth of a rectangular wave guide excited by the magnetron. The observations were made in an atmosphere of only 10 mm of Hg pressure in order to minimize the radiometer effects. When intercepting the maximum radiation (approximately one fifth of the total available power), the balance indicated a torque of 10^{-2} dyne/cm. Diffraction phenomena explain this result, which is smaller than the theoretical torque corresponding to a force obtained by calculating the product of the pressure of the intercepted radiation by the effective cross section of the blade. In a theoretical paper, it was demonstrated that within a (rectangular) wave guide the pressure must be calculated with the formula:

$$p_g = 2Sv_g/c^2$$

where v_g is the group velocity, which is known to be less than c. Measurements of p_g are under way, and since v_g is a calculable quantity, the authors hope to obtain the value of S as a final result and consequently the generated power.

998 Second sound velocity in helium II. R. D. Maurer and M. A. Herlin. MIT Research Laboratory of Electronics Technical Report No. 124, June 13, 1949. 6p. (NP-954).

Pulse methods are applied to extend the measurements of second sound velocity in liquid helium II to a temperature of 0.86°K. The rise in velocity below 1.1°K observed elsewhere is verified and extended to lower temperature. The theoretical implications are discussed.

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999 The surface photoelectric effect. R. E. B. Makinson. *Phys. Rev.* 75, 1908-11(1949) June 15.

An expression is derived for the photoelectric current produced at the surface of a metal, the conduction electrons being supposed free and the potential barrier of arbitrary shape. The validity of the common assumption that the current arising from conduction electrons of a particular momentum can be expressed as the product of an excitation function and a transmission coefficient is examined. It is concluded that the assumption is valid in general. The possibility of excitation of a resonant cavity at microwave frequencies by means of "beats" in the photoelectric current produced by two sharp adjacent spectral lines is also briefly discussed.

1000 Survey of methods used to determine the optical properties of phosphors. W. B. Nottingham. MIT Research Laboratory of Electronics Technical Report No. 110, May 10, 1949. 14p. (NP-952).

A brief review of the theory of phosphors is given in terms of the electron-band picture of impurity semiconductors in order to show the reasons for researches designed to obtain the optical properties of phosphors. The automatic spectroradiometer is described, since it is an instrument which yields so much information of value in phosphor research, development and quality control. Some problems of spectroradiometer standardization are discussed in detail, since the data obtained cannot be correctly explained by the I.C.I. system of color specification and interpretation unless satisfactory standards are maintained and used. A brief discussion is given of the application of the I.C.I. system to aid in the choice of phosphors required to produce a suitable "white" for television cathode-ray tubes. Other researches discussed include the determination of phosphor excitation curves, the emission of light as a function of temperature and of time, and the correlation of spectral excitation and absorption data.

1001 Trapping in solids. R. H. Bube, S. Lasof, and H. W. Leverenz. Radio Corporation of America Interim Report No. 2, Oct. 15, 1948. 37p. (NP-914).

Phosphors with an exponential decay may be differentiated from those with a power-law decay by the presence of low-lying highly localized impurity-introduced levels, such that no local or remote trapping is encountered either upon excitation or return. Such highly localized levels are absent for power-law decay phosphors and either (1) semi-localized high-lying levels give rise to trapping in the vicinity of the center, or (2) entrance of the excited electron into the conduction band gives rise to trapping at some distance from the parent center. The temperature dependence of efficiency and decay is the result of competition between a luminescence-producing and a dissipative transition. The behavior of traps under these circumstances can be seen simultaneously from related variations in efficiency and decay for four phosphors observed.

1002 Calibration of photographic emulsions for low energy electrons. L. Cranberg and J. Halpern. University of Pennsylvania, nd. 23p. (NP-949).

Measurements are reported for the dependence on energy of photographic darkening due to electrons of energies between 4.4 and 45 kev. For Ilford B-2 plates, in the linear density exposure region, the results can be expressed by the empirical formula $\frac{D}{Q/A} = KE^x$. D is the photometric density, Q/A the exposure in electrons/mm^2, E the energy in electron-volts, K and x are constants with the values $(0.30 \pm 0.03) \times 10^{12}$ and 1.45 ± 0.05, respectively. The results for two other emulsions tested is complicated by the presence of surface coatings on the emulsions. Reproducibility of results is discussed. Results are given on density fluctuations due to granularity of Ilford and x-ray emulsions. The limit of sensitivity, using the Leeds and Northrup recording microphotometer with scanning beam 1.0 by 1.3 mm, is estimated at 450 electrons/mm^2 of 40 kev energy for the x-ray emulsion and 680 electrons/mm^2 for the Ilford plates. The latter is limited by photometric sensitivity.

1003 A direct method of measuring nuclear spin-lattice relaxation times. L. E. Drain. *Proc. Cambridge Phil. Soc.* 62A, 301-6(1949) May 1.

A direct method of measuring nuclear spin-lattice relaxation times is described which is based on Bloch's nuclear induction experiment (*Phys. Rev.* 70, 460(1946)), in which the material investigated is subjected to a magnetic field that is varied several times per second

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through the value for nuclear resonance. Under certain conditions a simple calculation may be made of the relation between the magnitude of the nuclear induction effect, the relaxation time, and the time intervals between successive passages through resonance. Experimental observation of this relation then determines the relaxation time directly. The following relaxation times for protons in various substances were determined at 8Mc/sec: (1) paraffin wax at room temperature, 0.02 sec; (2) glycerine over the range -20° to $+50^{\circ}$C, 0.2 sec at 54°C, 0.005 sec at -12°C; (3) liquid hydrogen at boiling point, 0.2 - 0.5 sec; and (4) distilled water at room temperature, 2.7 sec. It is noted that the range of relaxation times which can be measured with a 50-cycle sweep is from about 0.1 sec to 0.005 sec. By using lower frequencies it should be possible to extend the range to connect up with the direct timing method. To determine shorter relaxation times, it would be necessary to use a higher frequency of sweep but, owing to the adiabatic condition, the radio-frequency field would have to be increased, too. This, besides entailing a larger oscillator and more heating of the coil, increases the trouble from microphonics and other sources of interference. It is also important that the transverse relaxation time be long compared with the time spent in resonance.

1004 The distribution of arc-chord differences in scattered particle tracks. W. T. Scott *Phys. Rev.* 75, 1763-4(1949) June 1 (Letter to the editor).

The statistical distribution of the arc-chord difference (the difference between the actual length of a particle track and the chord joining both ends) is discussed. As expected the arc-chord difference is subject to larger fluctuations than is the usual measure of scattering. Calculations are given for the case of constant energy which, although not applicable in the case of nuclear emulsions, allows an explicit result which serves to compare the two methods. Curves are shown of the distribution function for arch-chord differences and of the distribution function for the sum-of-squares of chord angles. Both are given as functions of the apparent mass, too, thus eliminating the necessity for explicit inclusion of range and energy. It is noted that although the arc-chord difference is certainly a less precise measure of the scattering, in some cases, such as in the distinquishing meson masses, neither the aforementioned nor the separate chord-angle method has any reliability closer than the values used in the preparation of the figures.

1005 The fogging of photographic materials by radiographic radium. H. F. Kaiser. Naval Research Laboratory Report NRL-M-1547. July 25, 1939. 17p.

A varietyof commercial photographic and x-ray films were exposed under conditions simulating actual shipping conditions at several distances from a standard 250 mg radium capsule enclosed in its Pb carrying case. The exposures required in each case to produce a density gain of 0.07 were determined and a table was constructed giving the permissible transit times for each kind of film when 15 feet from the radium unit. These values are at least several times those permitted for the same conditions by present railway express regulations.

1006 Geiger counter technique for high counting rates. C. O. Muehlhause and H. Friedman. Naval Research Laboratory Report NRL-H-2758, Feb. 11, 1946. 23p.

Electronic technique is described for extending the upper limit of counting rates with Geiger-Mueller counters from the usual maximum of about 2500 cts/sec to roughly 100,000 cts/sec. A theory is proposed to explain the counting process at these high rates and the observed dependence of resolving power on counting rate. The report includes details of the design of a double pulse generator working down to separations of about 0.3 μ sec, and a scaling circuit capable of resolving about 1 Mc/sec of periodic pulses.

1007 Geiger counter tubes. H. Friedman. *Proc. Inst. Radio Engrs.* 37, 791-808(1949) July.

The following are some of the many processes that contribute to the mechanism of the discharge in Geiger counters: formation of the primary ion pairs; ion multiplication within the gas by Townsend avalanche formation; spreading of the avalanches through photoelectric absorption of ultra-violet quanta in the gas; transfer of ionization energy from positive ions of the rare gases to the polyatomic molecules of the "quenching" admixture; release of secondary electrons at the cathode by positive ions and metastable atoms; de-excitation of metastable atoms of the rare gases by collisions with atoms of admixed foreign gases; and decomposition of polyatomic molecules by electron impacts and photon absorption. Present theories provide a qualitative understanding of the fundamental roles played by all of these processes, but

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their combined effects are too complex to predict the wide variation in characteristics of tubes obtained with slightly altered practices of construction or choices of gases. This paper is a review of existing theories and methods of constructing tubes to obtain maximum counting efficiencies and other desirable characteristics, such as low threshold voltage, thermal insensitivity, long life, high resolution, and low background. The Geiger-counter tubes are used for the detection of cosmic rays, x-rays, γ-rays, β-particles, and ultra-violet light.

1008 Interim report on subminiature corona regulator tubes. H. P. Gauvin and H. Friedman. Naval Research Laboratory, May 12, 1949. 12p. (NP-878).

The results described show that a tube structure of the BS-2 type, with the substitution of a larger diameter anode, can be utilized directly as a subminiature version of the BS-101 corona regulator tube, and is equally well suited for use at higher voltages such as required for the d-c "Poppy" type of alpha counter. The dependence of starting voltage on gas pressure in the lower voltage range is illustrated. The regulation characteristic of the 3/16 in. tube near the lowest usable voltage with a hydrogen filling is given.

1009 A photographic method for the absolute dosage of neutrons in an atomic pile. P. Cuer, M. Morand, T. King, and R. Locqueneux. *Compt. Rend. 228*, 557-9(1949) Feb. 14 (in French).

The reaction $N^{14}(n,p)C^{14}$ had been studied with the aid of charged photo-emulsions by one of the authors (Cûer. *J. Phys. Radium 8*, 83(1947)). This procedure was applied to the measurement of the stream of neutrons in a graphite column of the Harwell pile. A preliminary statement is made here of some of the results obtained pertaining to the number of neutrons recorded and to the neutron-filtering properties of graphite. The number of neutrons per cm^2 of plate can be accepted as equal to $n/M.dR.\sigma$, where n is the number of disintegration images per cm^2, M is the number of nitrogen atoms per cm^3 of emulsion, dR is the thickness of the unexposed emulsion film, and σ is the effective cross section of the disintegration. A critical examination is made of the degree of uncertainty associated with the determination of every magnitude involved. The data on the neutron stream in the pile, to check those obtained by the new method, are awaited from Harwell.

1010 Radio progress during 1948 – nuclear studies. *Proc. Inst. Radio Engrs. 37*, 319-21 (1949) Mar.

A review of the literature of 1947-48 on electronic circuitry (nuclear) and radiation-detector components.

1011 A self-sufficient apparatus for Geiger-Müller counters. L. Simons and B. Grotenfelt. *Soc. Sci. Fennica Commentationes Phys. Math. 13*, no. 17 (1949).

This article describes and illustrates a Geiger-Müller aggregate comprising a high voltage source, a Neher-Harper stage, a scaling circuit, and a thyratron stage for the mechanical recorder. A unit of this type is in regular use at the Physical Institute of Helsinki University.

1012 Sensitivity of a fast neutron counter for a near source. BR-311A, nd. 7p,

An investigation of an assumption that the efficiency of the counter is independent of the distance of the source, the net efficiency being assumed proportional to the solid angle subtended by the outer surface of the counter at the source, is reported. The sensitivity of a paraffin-lined counter for different distances of the source (the emergence of projected protons from an "infinitely thick" plane layer and for the spherical counter) is considered.

1013 Sensitivity of quantitative autoradiography. K. Zuber, *Helv. Phys. Acta 22*, 112-8 (1949) (in German) (See also Nuclear Science Abstract 1-1877).

The darkening of photographic films by radioactive substances was measured, and the corresponding ray number computed, with a view to determine conditions when the photographic (autoradiographic) method is to be preferred to the use of counters. Gold coins were irradiated with slow neutrons; Au^{198} (2.66 days) is formed, which emits β-rays of 0.970 Mev maximum energy. These coins were placed between Kodak Ultra-Speed X-ray films, and left there for 5 days. The evaluation of the ray number was based on a microscopic counting of Ag-grains and on considerations which had been developed by Webb (*Phys. Rev. 74*, 511(1948)). As a result, about 500 β-rays/mm^2 produced a 0.01 darkening, the probable error being 20%. This is compared with the value (1.6×10^5 β-rays/mm^2 for a 0.06 darkening) found for C^{14} by Cobb and Solomon (*Rev. Sci. Instruments 19*, 441(1948)). The general conclusions are the following:

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the film method has advantages over the use of counters in cases when only very few electrons are emitted every minute (0.2 in the case here studied); for a β- spectrum with a 1 Mev limit, the half life should be long enough to permit an emission of at least 500 rays/mm^2 of film; for softer rays (as is the case with C^{14}), the corresponding number is about 5 times larger.

1014 Invariant classification of the terms of the matrix S. A. Houriet and A. Kind. *Helv. Phys. Acta 22*, 319-30(1949) June 30 (in French).

In order to eliminate the divergencies introduced by the perturbation theory from the second order on, the terms of each order can be resolved into classes invariant for a Lorentz transformation. The exposition is based on the theory of graphs.

1015 Meson exchange and spin-orbit coupling in nuclei. D. R. Inglis, *Phys. Rev. 75*, 1767-8(1949) June 1 (Letter to the editor).

An attempt is made to account for the single-nucleon spin-orbit coupling required by recent conjectures (*Phys. Rev. 75*, 1767(1949)) concerning the prevalence of a j-j coupling scheme since it is too strong a coupling to be accounted for by the simple theory based on a Thomas precession. It is suggested that the process of meson exchange which binds a circulating nucleon to the rest of the nucleus involves a predominantly centripetal acceleration of the meson momentarily associated with the circulating nucleon. This meson acceleration is expected to be much greater than the centripetal acceleration of the nucleon. This would give rise to a Thomas precession of the meson spin much more rapid than that of the intrinsic nucleon spin previously derived and to a spin-orbit coupling much larger than that arising from precession of the nucleon spin alone. It is concluded that it is more likely that a spin-orbit coupling belonging to each individual nucleon would arise from this second-order relativistic effect than from the second-order perturbation theory with a tensor interaction, as treated by Dancoff (*Phys. Rev. 58*, 326(1940)) in the simple case of He^5 with only one circulating nucleon.

1016 The meson fields and the equation of motion of a spinning particle. R. C. Majumdar and S. Gupta. *Phys. Rev. 75*, 1788-93(1949) June 15.

Using the method recently developed by Riesz (*Congr. réunion intern. math.* (1939)) for solving differential equations of the hyperbolic type, the meson fields generated by a point dipole at a point outside the world line have been defined in terms of the derivatives of an integral which is an analytical function of a parameter, α, and which converges for α lying between $2<\alpha<3$. It is then shown that by the process of analytical continuation of the parameter to the value $\alpha = 2$ for which the Riesz fields satisfy the fundamental meson field equations, both the classical Liénard-Wiechert-Bhabha fields at a point outside the world line and a field at a point on the world line itself which is finite and represents the reaction of the field correctly are obtained. The equations for the rotational and translational motions follow immediately from the usual electrodynamical equations of a dipole given by Frenkel (*Z. physik. 37*, 243(1926)). The equations thus obtained are free from singularites and do not contain any arbitrary constant except the mass and spin angular momentum of the dipole.

1017 A method for the elimination of infinities in the theory of quantized fields. Application to the magnetic moment of the neutron. D. Rivier. *Helv. Phys. Acta 22*, 265-318(1949) June 30 (in French).

The method used in this study is due to Stueckelberg (*Helv. Phys. Acta 11*, 3, 221(1938), *18*, 1, 21(1945), *18*, 3, 19(1945), *19*, 4, 241(1946)). Instead of the Hamiltonian operator, the new theory studies the integral operator S giving the evolution of the function ψ between any two epochs τ'' and τ', $\psi[\tau''] = S[\tau'',\tau']\psi[\tau']$. The theory is applied to the computation of the magnetic moment of the neutron in its third approximation, a value that is known to be infinite. A way is shown to render it finite through an appropriate modification of the operator S, leaving unchanged the latter's essential properties of invariance, causality, and unitarity, However, these conditions do not suffice to determine S completely. Accordingly, the neutron's magnetic moment is left undetermined, too; a simple rule permits, however, to determine it unambiguously.

1018 Non-radiating Maxwell waves. G. A. Perkins. *Phys. Rev. 75*, 1947(1949) June 15 (Letter to the editor).

It is shown that a single restriction consistent with Maxwell's field equations, and equivalent to zero permeability, puts these equations in a form for which all solutions are

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non-radiating. It is noted that the time average of the charge density can be considered to be distributed according to Schrödinger's equation, with a superposed charge density which oscillates with twice the de Broglie frequency, without radiation. Present study indicates that a comprehensive theory can be formulated along these lines, the time-dependence of the charge density removing the chief difficulties encountered by such theories in the past.

1019 On the classical radiation of accelerated electrons. J. Schwinger. *Phys. Rev.* 75, 1912-25(1949) June 15.

This paper is concerned with the properties of the radiation from a high energy accelerated electron, as recently observed in the General Electric synchrotron. An elementary derivation of the total rate of radiation is first presented, based on Larmor's formula for a slowly moving electron, and arguments of relativistic invariance. An expression for the instantaneous power radiated by an electron moving along an arbitrary, prescribed path is then obtained. By casting this result into various forms, the angular distribution, the spectral distribution, or the combined angular and spectral distributions of the radiation may be obtained. The method is based on an examination of the rate at which the electron irreversibly transfers energy to the electromagnetic field, as determined by half the difference of retarded and advanced electric field intensities. Formulas are obtained for an arbitrary charge-current distribution and then specialized to a point charge. The total radiated power and its angular distribution are obtained for an arbitrary trajectory. It is found that the direction of motion is a strongly preferred direction of emission at high energies. The spectral distribution of the radiation depends upon the detailed motion over a time interval large compared to the period of the radiation, However, the narrow cone of radiation generated by an energetic electron indicates that only a small part of the trajectory is effective in producing radiation observed in a given direction, which also implies that very high frequencies are emitted. Accordingly, the spectral and angular distributions of the high frequency radiation by an energetic electron are evaluated in their dependence upon the parameters characterizing the instantaneous orbit. The average spectral distribution, as observed in the synchrotron measurements, is obtained by averaging the electron energy over an acceleration cycle. The entire spectrum emitted by an elelctron moving with constant speed in a circular path is also discussed. Finally, it is observed that quantum effects will modify the classical results here obtained only at extraordinarily large energies.

1020 On a general theory of particles with a given total spin. R. Potier. *Compt. rend.* 228, 656-8(1949) Feb. 21 (in French).

The following problem is discussed: a certain total spin being assigned to a particle, which is the most general system of corresponding wave equations invariant for every Lorentz transformation and satisfying wave-mechanical conditions? The discussion of the problem follows certain general procedures proposed by the author in a series of notes, beginning in *Compt. rend* 222, 638(1946), (the last cited is *Compt. rend.* 227, 1146(1948)). Among the results obtained is the freedom from any restrictions concerning the proper masses of the particle considered, a conclusion leading to that of an infinity of masses, analogous to the infinity of states of rest energy in a nucleus. It should be admitted, therefore, that the so-called elementary particles possess excited states, whose proper masses exceed that of the usually accepted proper mass. The formalism here presented permits a coherent relativistic representation of material systems such as nuclei, which avoids the arbitrary distinction between systems and elementary particles.

1021 On generalizing boson field theories. A. E. S. Green. *Phys. Rev.* 75, 1926-9(1949) June 15.

If a boson field theory is generalized to admit all the derivatives of the field coordinates up to the σ th in a particularly symmetrical way in the field Lagrangian, then it is found that in the field expression for the interaction energy of fermions, the usual interaction is replaced by a weighted sum of σ such interactions, where the relative weight factor and the boson mass associated with each interaction are given uniquely by algebraic relationships involving the constants appearing in the field Lagrangian. It is thus possible to formulate a simple principle for obtaining the interaction energy according to a multiple-boson theory of the form suggested by the generalizations if the interaction energy is known for the one-boson case. The principle is then applied to the non-relativistic and relativistic interaction terms for electrons according to electrodynamic (photn) field theory, and for nucleons according to the meson field theories investigated by Kemmer (*Proc. Roy. Soc. A166*, 127(1938)). In almost every case the weight

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factors are such that not only are the inadmissible R^{-3} and R^{-2} singularities removed, but also in three- and four-boson theory, the objectionable R^{-1} singularities. A closely related result is the fact that generalization justifies the neglect of short wave lengths in the evaluation of the interaction and self-energy integrals.

1022 On Sommerfeld's "Radiation Condition." F. V. Atkinson. *Phil. Mag. 40*, 645-51 (1949) June.

The restrictions placed by Sommerfeld (*Deut-math-verein 21*, 309-53(1912)) on the problem of wave motion involving an infinite medium and boundary conditions in order to determine the solution uniquely, are considered. A proof that Sommerfeld's restrictions make the problem unique is given; it is also shown that Sommerfeld's two conditions may be replaced by one, and that within certain limits the exact form of the conditions is not important.

1023 Radiation corrections to Dirac's equation. A. D. Galanin. *Zhur. Eksptl. i Teoret. Fiz. 19*, 521-34(1949) June (in Russian).

An investigation is made of interactions of an electron with zero oscillations of an electromagnetic field and with background electrons of negative energy, the approximation being that of the square of the electron's charge. The infinite elelctromagnetic mass of the elelctron and its "mechanical" mass are united into an "experimental" mass. The identification of various terms with the proper mass is made possible by the fact that in Dirac's Hamiltonian the mass is multiplied by the matrix β. The remaining finite operator is considered as representing the experimentally observed outcome of the interaction between the electron and the zero oscillations of the field. This operator determines the level shifts in the hydrogen atom (Lamb and Rutherford, *Phys. Rev. 72*, 241(1947)) and the anomalous magnetic moment of the electron (Kusch and Foley, *Phys. Rev. 74*, 250(1948); Nafe and Nelson, *Phys. Rev. 73*, 718(1948); Breit, *Phys. Rev. 74*, 656(1948)).

1024 The theory of the electron. W. Wessel. University of Heidelberg, FIAT-1131, nd. 20p. (in German).

The author develops a classical theory of the spinning electron based only on the variables used by Dirac, viz spatial coordinates, momentum, velocity, and mass, as well as the antisymmetrical tensor of magnetic and electric moments. Equations of motion are set up by formation of Poisson-brackets of the variables with a Hamiltonian function identical with Dirac's. The necessary relations of the variables are established using a reduction to spinors originated by Darwin, and Laporte and Uhlenbeck. Eliminating all additional variables by differentiation of the spatial coordinates the usual equation of motion of a charged particle increased by certain members with higher derivatives, characteristic for particles with a finite extension in space, is obtained. It is intended by conversion of the Poisson-brackets into commutation-relations, to include the reaction of radiation and higher order forces on the ordinary quantum-mechanical formalism. A difficulty of a former paper on this topic is removed.

1025 Theory of plasma oscillations. Part A. Origin of medium-like behavior. D. Bohm and E. P. Gross. *Phys. Rev. 75*, 1851-64(1949) June 15.

A theory of electron oscillations of an unbounded plasma of uniform ion density is developed, taking into account the effects of random thermal motions, but neglecting collisions. The first problem considered is that of finding the frequencies at which a plasma can undergo organized steady-state oscillations of small enough amplitude so that a linear approximation applies. It is found that long wavelength oscillations of plasmas with a Maxwell distribution of electron velocities are characterized by the steady-state dispersion relation $\omega^2 = \omega_p^2 + (3_K T/m)(2\pi/\lambda)^2$. Here ω_p is the plasma frequency, T the absolute temperature of the electron gas, λ the wave length, and ω the angular frequency of oscillation. It is also shown that organized oscillations of wave lengths smaller than the Debye length for the electron gas are not possible.

The theory is then extended to describe the processes by which oscillations are set up. It is found that, for a given wave length, a plasma can oscillate with arbitrary frequency, but that those frequencies not given by the steady-state dispersion relation describe motions in which, after some time, there is no contribution to macroscopic averages. These additional frequencies lead asymptotically only to microscopic fluctuations of the charge density about the organized oscillation of the plasma. In this way, the manner in which the system develops organized behavior can be described.

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The treatment is then applied to large steady-state oscillations for which the equations are non-linear. Solutions are obtained in which particles close to the wave velocity are trapped in the trough of the potential, oscillating back and forth about a mean velocity equal to that of the wave. Non-linear traveling pulse solutions can also be obtained, in which a group of particles, moving as a pulse, creates a reaction on the surrounding charge which traps the particles and holds them together.

1026 Theory of plasma oscillations. Part B. Excitation and damping of oscillations. D. Bohm and E. P. Gross. *Phys. Rev.* 75, 1864-76(1949) June 15.

The theory of electron oscillations of an unbounded plasma is extended to take into account the effects of collisions and special groups of particles having well-defined ranges of velocities. It is found that as a result of collisions a wave tends to be damped in a time of the order of magnitude of the mean time between collisions. If beams of sharply defined velocity or groups of particles far above mean thermal speeds are present, however, they introduce a tendency toward instability so that small oscillations grow until limited by effects not taken into account in the linear approximation. An estimate is made of the steady-state amplitude for plasma oscillations in which excitation occurs because of a peak at high velocities in the electron velocity distribution, and in which the main damping arises from collisions. It is also found that in variable density plasmas, waves moving in the direction of decreasing plasma density show even stronger instability. In the absence of plasma oscillations, any beam of well defined velocity is scattered by the individual plasma electrons acting at random, but, when all particles act in unison in the form of a plasma oscillation, the scattering can become much greater. Because of the instability of the plasma when special beams are present, the beams are scattered by the oscillations which they produce. It is suggested that this type of instability can explain the results of Langmuir, which show that beams of electrons traversing a plasma are scattered much more rapidly than can be accounted for by random collisions alone. It is also suggested that this type of instability may be responsible for radio noises received from the sun's atmosphere and from interstellar space.

1027 Transport phenomena in a Bose-Einstein gas. W. Band. *Phys. Rev.* 75, 1937-46(1949) June 15.

The formal first order perturbation theory of transport phenomena in an ideal Bose-Einstein gas is developed. It is noted that in this theory the perturbation relaxation time is an unknown parameter. The ratio of thermal conductivity to viscosity is independent of this relaxation time; it increases discontinuously by a factor almost 2 at the Bose-Einstein condensation temperature T_λ. The isothermal Knudsen heat of transport through a small hole, classically equal to $2kT$, drops rapidly to zero as T falls to T_λ: the Bose-Einstein gas flowing isothermally through a small hole carries no heat when its temperature is below T_λ and it exhibits corresponding thermomechanical effects. The mathematical analysis is carried out in terms of an approximation in which the lowest energy states of the gas are treated discretely while above an arbitrary level they are treated by an integration approximation. It is possible to generalize this treatment and extend it to models in which there are anomalies in the lowest level spacings.

1028 Dual decay of In^{114}. F. Boehm and P. Preiswerk. *Helv. Phys. Acta* 22, 331-8(1949) June (in German).

According to Lawson and Cork (*Phys. Rev.* 57, 982(1940)), In^{114} (72 sec), which is formed from its 50-day isomer, undergoes a β-disintegration resulting in Sn^{114}. The β-spectrum of In^{114} has an upper limit of 1.98 Mev and agrees will with Fermi's theory of permitted transitions; accordingly, it has occasionally been used as a gauge spectrum. However, the authors were able to ascertain that the disintegration of In^{114} is of a more complex nature. As a dual to the β-process, there is a $(3\pm 1)\%$ fraction consisting of K-captures that result in an excited state of Cd^{114}. The K-capture is followed by the emission, in cascade, of two γ-lines, of 715 ± 10 kev and 548 ± 10 kev. Some observations seemed to indicate also the existence of a positron reaction with a frequency of 10^{-4} per electron and a limit energy of 650 ± 100 kev.

1029 The fine structure of γ-lines of RaC. V. V. Gei, G. D. Latyshev, and M. V. Pasechnik. Doklady Akad. *Nauk S. S. S. R.* 63, 239-42(1948) Nov. 21 (in Russian).

A detailed study was made of the principal lines of the γ-spectrum of RaC, by measuing the electron spectra of the K-level internal conversion for the lines 1414, 1760, and 2198 kev. The total widths of the last two lines and the positions of their respective components agree with the

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details of the corresponding positron spectra. The components are 6.2 kev apart. In the line 1414 kev each component is split into two lines 2.4 kev apart. This fine structure of the three lines studied is best interpreted by a rotating model of the nucleus, in which the lines corresponding to a rotating structure are superimposed upon a spectrum of fundamental lines corresponding to some internal nuclear changes which may be of a vibrational character. Assuming this interpretation, the author calculates the nuclear radius of RaC′, $R = (8.88 \pm 0.3)10^{-13}$ cm. Substituting this into the formula $R = r_0 A^{1/3}$, we obtain $r_0 = 1.49 \times 10^{-13}$ cm. Amaldi (*Phys. Rev.* 71, 739(1947)), studying the scattering of rapid neutrons, found for the coefficient r_0 the value 1.52×10^{-13} cm, while Preston (*Phys. Rev.* 71, 865(1947)), from his measurements of the α-decay energies, obtained an average $r_0 = 1.51 \times 10^{-13}$ cm.

1030 Monochromatic positrons of internal conversion. G. D. Latyshev. V. V. Gei, A. A. Bashilov, and I. F. Barchuk. *Doklady Akad. Nauk S.S.S.R.* 63, 511-3(1948) Dec. 11 (in Russian).

Studying the positron spectrum of internal conversion of RaC′, the authors observed sharp monochromatic peaks superimposed on the continuous spectrum. These peaks are interpreted as being due to a special case of internal conversion, when the electron of a pair is captured by a free level in the atom's envelope. The kinetic energy of monochromatic positrons is $h\nu - 2mc^2 + P$, where $h\nu$ is the energy of the γ-quantum and P is the work of removal of an electron from a given level. The observed monochromatic peaks are L_{1527} and K_{1527}, corresponding to the γ-line 1527 kev and to captures by the shells L and K; and M_{1620}, corresponding to the γ-line 1620 kev and to a capture by the shell M. The ratio between the numbers of the monochromatic positrons and the pair positrons is equal to the ratio between the area S_m of the peak and the area S_p of the continuous positron spectrum; the theory gives for the latter ratio the formula $S_m/S_p = (w_m/w_p) \cdot w_K \cdot (G\gamma/G_K)$, where w_m is the probability of the formation of a monochromatic positron, w_p that of the appearance of a pair, w_K that of the appearance of a free level in the shell K, G_γ is the radiational width of the level corresponding to a given γ-line, and G_K is the total width of the K-level. For K_{1527} this formula gives $G_\gamma \cong 0.4$ ev. In a simil. manner, for L_{1527} $G_\gamma \cong 0.5$ ev.

1031 On nuclear energetics and β-activity. II. The groups I = 7 to I = 20. A. Saha, S. Ghoshal, and S. Das. *Trans. Natl. Inst. Sci. India* 3, No. 1 (1948) Feb. 66p.

This is an application of certain ideas developed in an earlier paper by M. N. Saha and A. K. Saha (*Trans. Natl. Inst. Sci. Ind.* 2, no. 7, p. 193) in which a modification of the Weizsacker-Bethe mass defect formula in the shape of a spin-dependent term was proposed. The authors have deduced from the Weizsacker-Bethe mass defect formula the numerical values of the energy releases in the case of β-emissions or K-capture decays of radio-elements of the groups I = 7 to I = 20. These values have been compared with the experimentally observed values for these quantities. Generally (as in the previous groups I = -1 to I = 6 discussed in the earlier paper) the comparisons lend support to the existence of the Saha-Saha spin dependent term in the mass defect formula. The tentative properties of this spin term (proposed in the first paper) are found sufficient to account for the energy releases in the β- or K-decays of radio-elements of the groups discussed. The paper contains a thorough critical review of the assignments of the periods for the β- or K-decays of these radioelements and the experiments performed to determine the energy releases in these decay processes.

1032 Progress report in physics, July 1 to December 31, 1948. W. C. Caldwell, J. F. Carlson, G. C. Danielson, E. N. Jensen, J. M. Keller, L. J. Laslett, S. Levgold, and G. Miller. Iowa State College Report ISC-46, June 16, 1949. 50p.

Definitive results are reported on the gamma radiations from Se^{75}, Yb^{169}, and Sb^{124}. The gamma spectrum of Eu^{154} and the beta spectra of Sb^{124}, P^{32}, Sr^{90}, and Y^{90} have also been measured but calculation of the data has not been completed. Instrumentation problems connected with the magnetic-lens spectometer are discussed, including the effect of source charging, the calculation of the effective aperture of the instrument, and the start made on a combined experimental and theoretical program to determine the effectiveness of ring-focusing in the instrument. The use of scintillation counters is also being studied. Developments in the use of a bent-crystal x-ray spectrograph, for the study of low energy nuclear radiations, and progress in the construction of a 12-in. cloud-chamber are described. The decay of Na^{22} is being followed and has led to a provisional half-life of 2.6 yr. Studies in the use of nuclear

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photographic emulsions are being continued. A program is being planned to investigate the properties of atomic particles in their passage through matter. Preliminary work is under way on the ionization and the loss of energy and charge of low energy protons and a similar program is in progress with fission fragments. A number of calculations have been made to determine the value of possible neutrino-recoil experiments. The program in solid-state physics is developing, with active work on scintillation counters, crystal conduction counters, photoconductivity semiconductors, dislocations in metals, and ferroelectric $BaTiO_3$. Work is continuing on the construction of a mass spectrometer. Progress on a number of projects of interest to, but not supported by, the AEC is summarized. Among these projects are the synchrotron and kevatron construction, and the erection of low temperature facilities.

1033 Three-photon annihilation of an electron-positron pair. A. Ore and J. L. Powell. *Phys. Rev. 75*, 1963(1949) June 15 (Letter to the editor).

It is noted that the results obtained by Landau (*Dokl. Akad. Nauk, SSSR, 60*, 207(1948)) and Pomeranchuk (*Dokl. Akad. Nauk. SSSR 60*, 213(1948)) are in agreement with those reported by the authors (*Phys. Rev. 75*, 1696(1949)), whereas the value obtained by Lifshits (*Dokl. Akad. Nauk, SSSR 60*, 211(1948)) gives a formula for the three-photon annihilation differential cross section which is in apparent disagreement with the results of Ore and Powell. As a consequence the life-time of the triplet ground state of the positronium atom is shortened by a factor of 1.6.

1034 Self-diffusion in stressed monocrystalline metals. R. A. Arnoldi. Stevens Institute of Technology Department of Physics Final Progress Report, Nov. 30, 1948. 17p. (NP-773).

Self-diffusion in stressed monocrystalline specimens of Zn and Cu is to be studied by radioactive tracer techniques. Suitable crystals have been grown by a technique similar to that of Bridgeman, their orientation determined by observation of reflections from etched surfaces, and electroplated with the radioactive isotope. It remains to conduct the actual diffusion runs, section the specimens, and determine the diffusion coeffients from the activities of the sections.